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ELECTRONIC DESIGN

DECEMBER 16, 1993

FOR ENGINEERS AND ENGINEERING MANAGERS—WORLDWIDE

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TOOLSET OPENS A WINDOW ON PLD DESIGN IN A MIXED-SIGNAL ENVIRONMENT

- 1993 TECHNOLOGY REVIEW
- COMPUTER SYSTEMS DESIGN SECTION
- PEASE PORRIDGE

Schematics: MOTOR.SCH p.1
Top 10 Solutions
Specific Device Information
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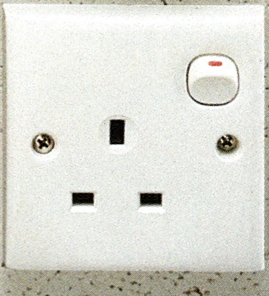

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- 3 FEB 1994

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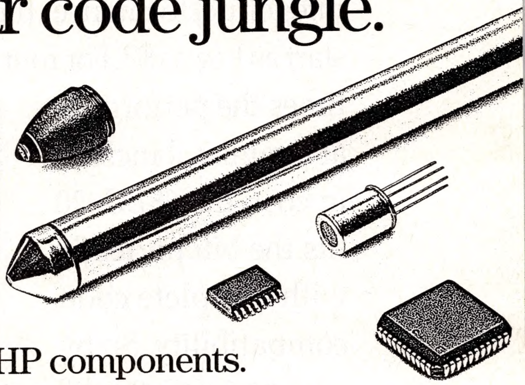

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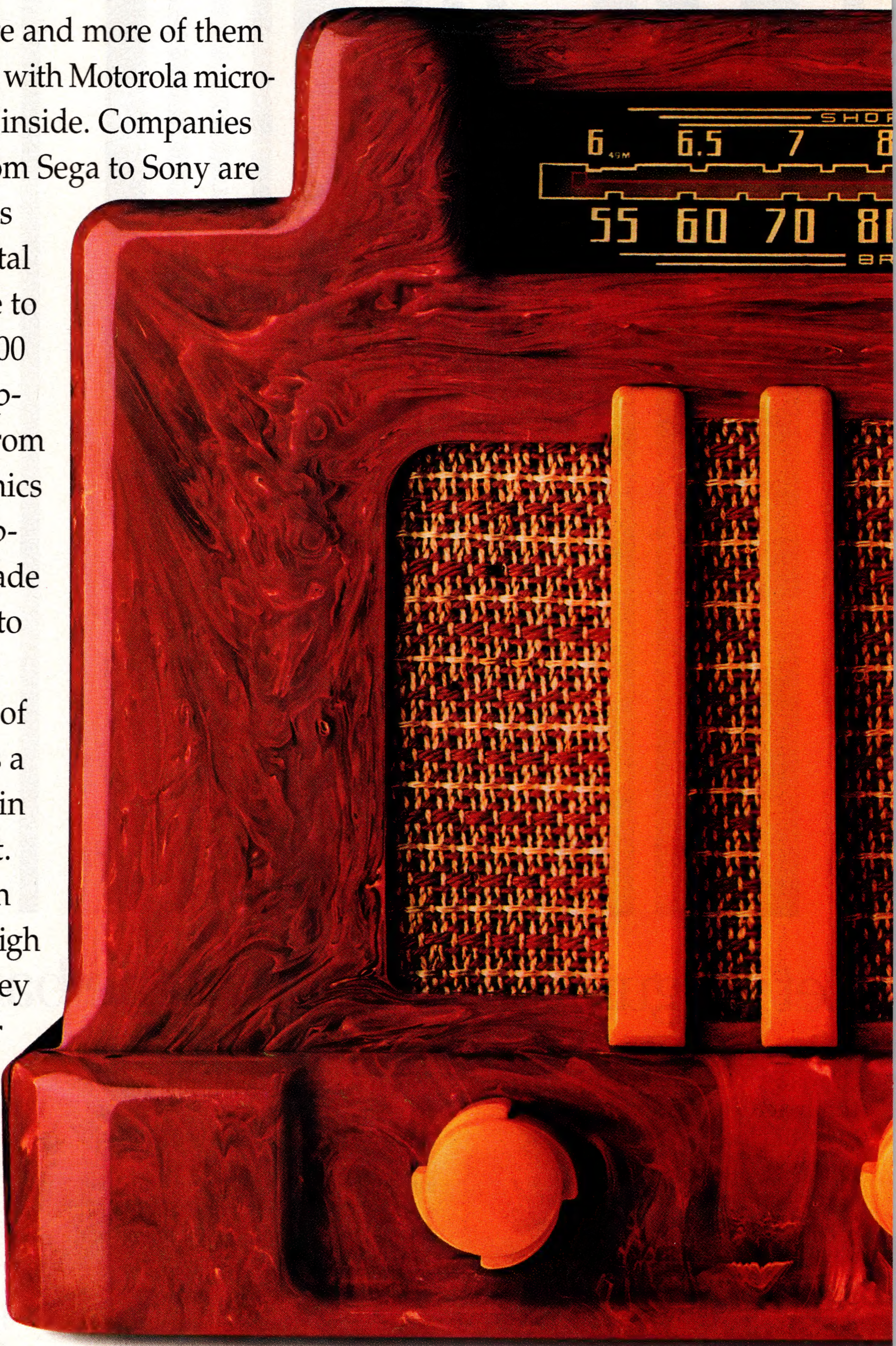

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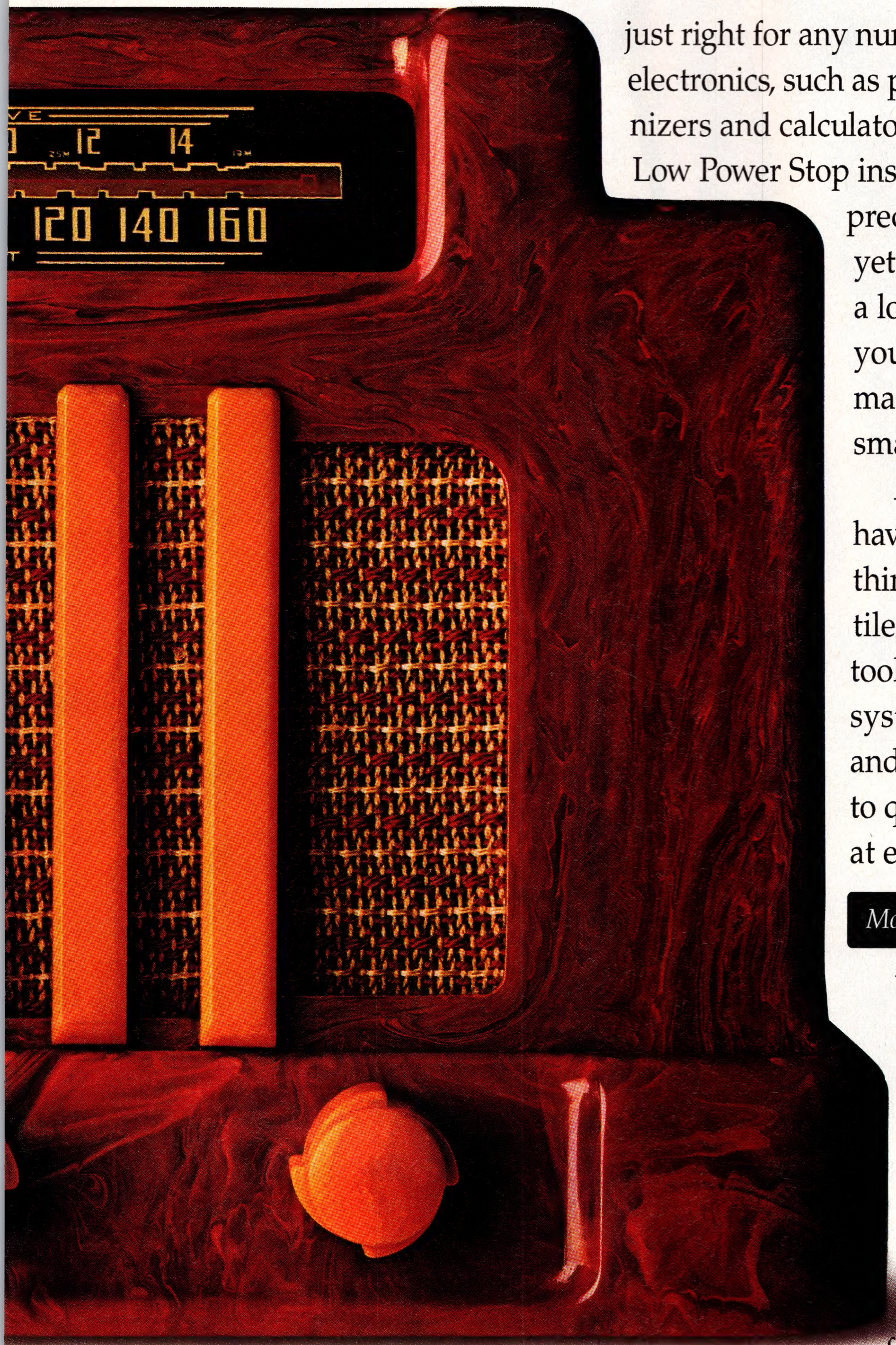

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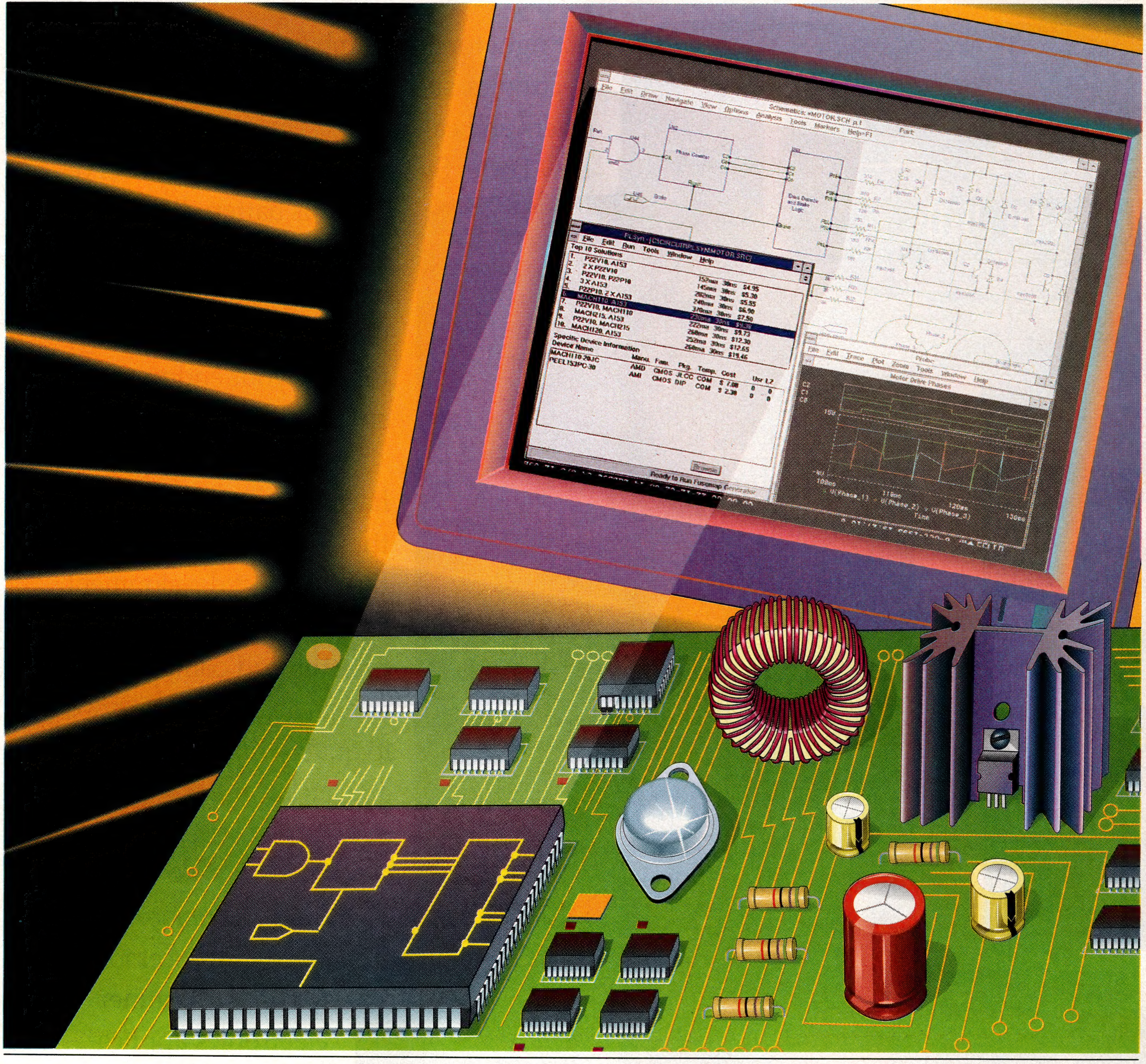
DECEMBER 16, 1993 VOL. 41, NO. 26

ELECTRONIC DESIGN



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Cover Illustration: Tony Vitolo

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- Analog semiconductors
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- Computer boards
- Power Supplies
- First details on a new high-speed LAN interface
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ELECTRONIC DESIGN (USPS 172-080; ISSN 0013-4872) is published semi monthly except for 3 issues in May and 3 issues in November by Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543. Paid rates for a one year subscription are as follows: $95 U.S., $175 Canada, $255 International. Second-class postage paid at Cleveland, OH, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 611 Route #46 West, Hasbrouck Heights, NJ 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204.

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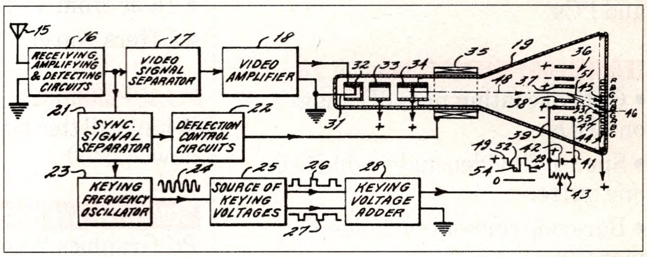
CIRCLE 206 FOR RESPONSE OUTSIDE THE U.S.

ELECTRONIC DESIGN 40 YEARS AGO

New Patents: Color Television Reproducing System ...Patent No. 2,540,264. P.K. Weimer. (Assigned to Radio Corp. of America).

The color TV receiver disclosed employs a single cathode-ray tube for reproduction of the primary color components of an image. The receiver is therefore less complicated than the systems heretofore proposed which required a cathode-ray image-producing device for each of the primary colors. Basically, the circuit includes the usual circuit elements (16, 17, 18, 21 and 22), and also includes a keying frequency oscillator (23) which produces a sine wave (24). From the sine wave, keying voltages 26 and 27 are derived which are added in the circuit component 28 to form a stepped voltage wave 29. The stepped voltage is applied to several pairs of spaced plates (37) and (38) within the cathode-ray tube, with each pair of plates forming an apertured color-selecting electrode.

There is one apertured electrode for each horizontal line. The CRT screen is provided with a group of horizontal strips, one for each primary color such as red, blue and green, and one group of strips for each horizontal line of the image. Each strip carries a phosphor for emitting its color when excited by the electron beam. In other respects the cathode-ray tube is conventional.



For a dot multiplex system of transmitting and receiving color images, the color signal changes for every dot or element area of the image. Assume that the first signal is red, the stepped keying voltage wave applies the maximum voltage 49 to the color selecting electrode 36 and the beam is deflected an amount to impinge on the red strip and red light is emitted. The next instant is a blue signal and the keying voltage applies the stepped voltage 52 to the color selecting electrodes so that the electron beam is deflected an amount to impinge the blue strip. The next instant is a green signal so that the beam is deflected by the lowest step 54 of the keying voltage to impinge the green strip. This cycle occurs continuously for each elemental area of each horizontal line of the image. It is apparent then that with the dot multiplex system the frequency of the stepped keying voltage is substantially three times the rate at which it is desired to reproduce the three color elemental image areas. The system may be used without structural change for line sequential reproduction in which case the frequency of the stepped keying wave is substantially equal to the horizontal line frequency. It may also be used in a field or frame sequential system in which case the stepped keying frequency is substantially equal to the field or frame frequency. *(Electronic Design, December 1953, p. 44.)*

Paul K. Weimer was a leading expert in TV camera tubes and thin-film technology at RCA's David Sarnoff Research Center, Princeton, N.J. Among his achievements are the development of the Image Orthicon and, in 1961, the first thin-film insulated-gate transistors, which were deposited on glass.—Ed.

New Literature: Electronic Equipment

A 224-page catalog contains illustrations, descriptions, and prices of an extremely wide variety of electronic equipment of different makes. It covers, among many other types of equipment: tubes, relays, switches, batteries, transistors, power supplies, transformers, inductors, capacitors, resistors, connectors, wire testers, amateur radios, audio amplifiers, tape recorders, p-a equipment, and books. Radio Shack Corp., 167 Washington St. Boston 8, Mass. *(Electronic Design, December 1953, p. 43.)*

We've presented many 1953-vintage items in this column over the past year, but this one shows that some things don't change: Radio Shack was going strong in 1953, and now its stores seem to be everywhere. Starting next issue: The highlights of 1954.—Ed.

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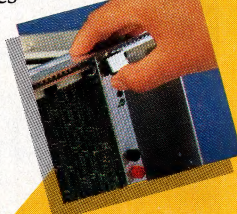

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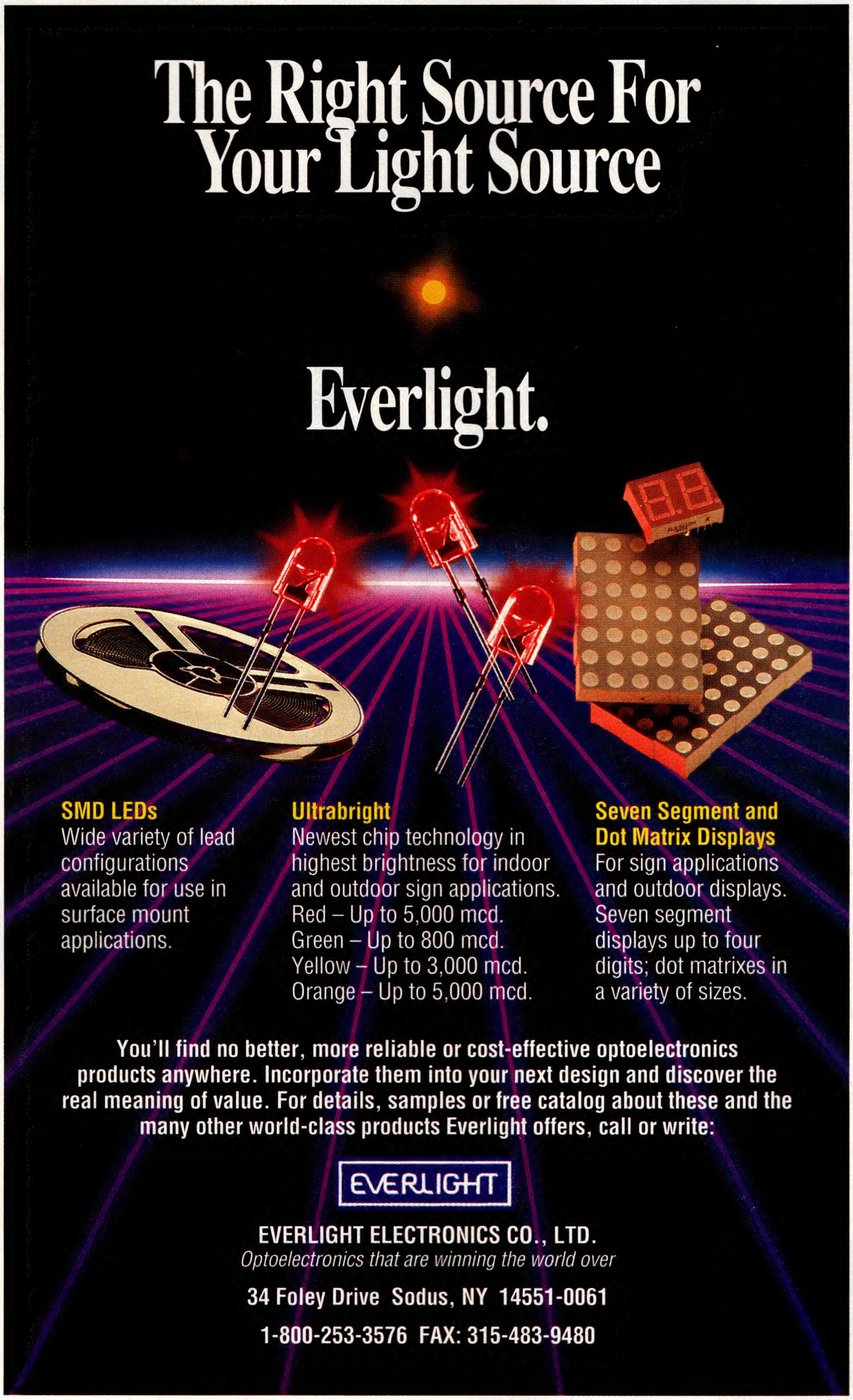

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To contact, call or write:
611 Route 46 West
Hasbrouck Heights, NJ 07604
(201) 393-6262 or (201) 393-6270
Fax (201) 393-0204

News Editor: Clifford Meth

Field Correspondents:
West Coast Executive Editor: Dave Bursky (San Jose)
Communications & Industrial: Milt Leonard (San Jose)
To contact, call or write:
2025 Gateway Plaza, Suite 354
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Chief Copy Editor: Roger Engelke Jr.

Contributing Editors: Ron Kmetovicz, Robert A. Pease

Editorial Production Manager: Pat A. Boselli
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Group Art Director: Peter K. Jeziorski

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Advertising Production:
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Production Manager: Mike McCabe
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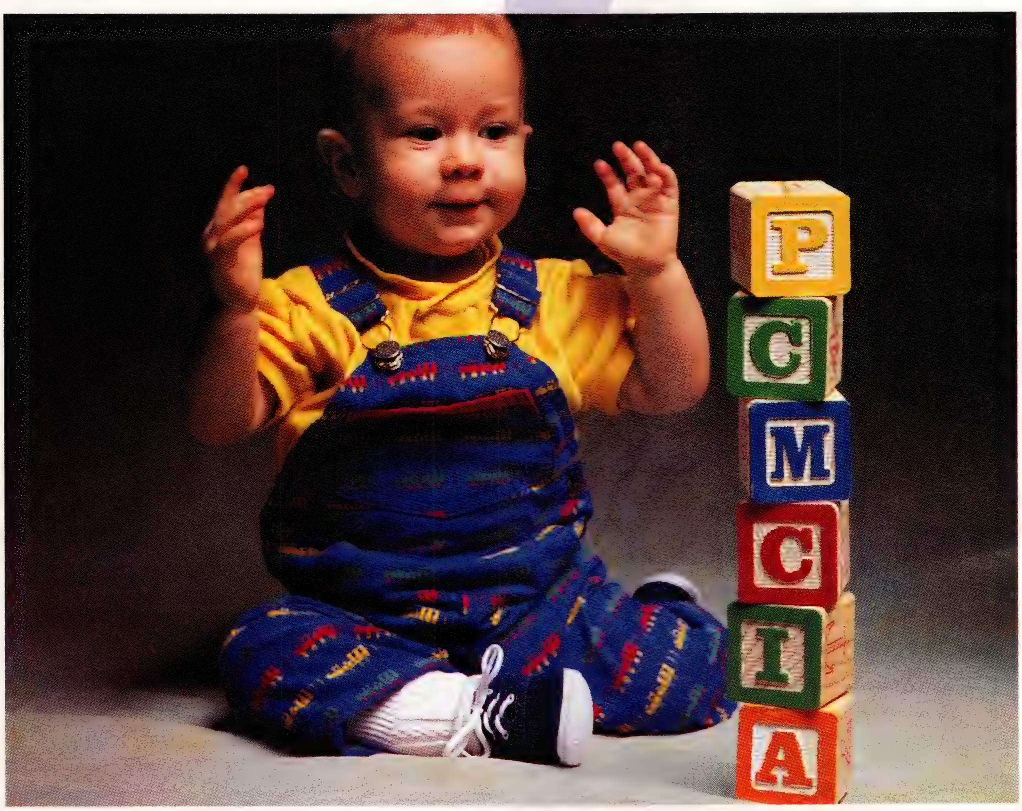

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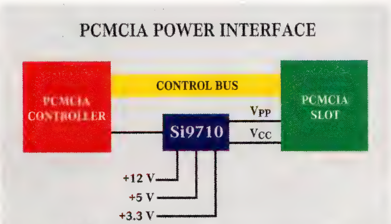

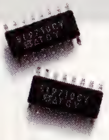

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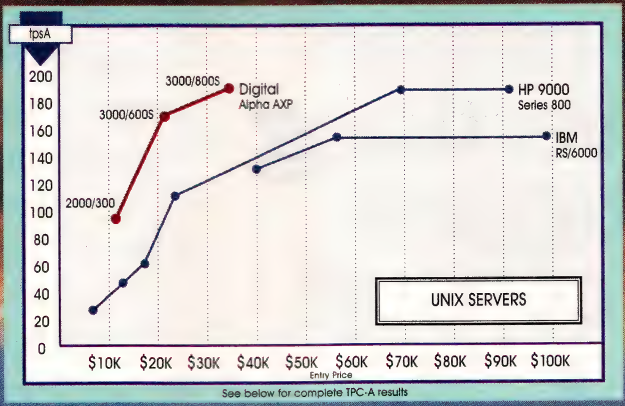

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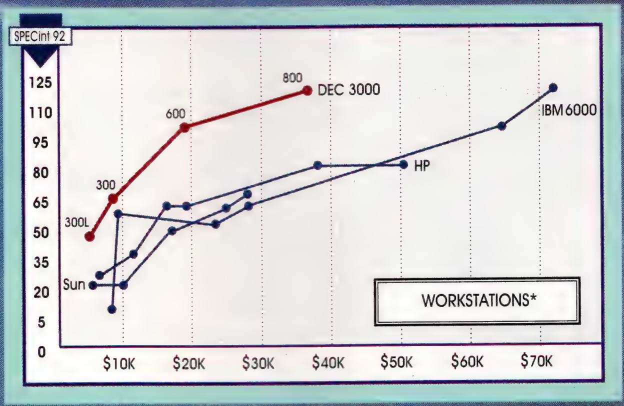

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Take the case of the Advertising Council's campaign against colon cancer. The first-ever study of public service advertising that actually isolated the impact of advertising from other market elements like the news, editorials and public relations.

Research was conducted from July 1989 to July 1990 in 4 markets in 10,000 households, at the equivalent of $21.3 million worth of air time, the average amount of donated time behind Advertising Council spots.

After six months of being exposed to one commercial, awareness of colon cancer among adults 40 and over rose from 11% to 29%.

After a year, awareness reached 40%.

The number of men who consulted their doctors more than doubled to 15%.

Now, if advertising can get people to see their doctors about something as unpalatable as colon cancer, don't you think it can get people to consider your product?

Oh, there's one more thing. If you're over 40, ask your doctor about colon cancer."

Herb Baum, Pres., Campbell North & South America and Chm. of the Advertising Council.

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This advertisement was prepared by Calet, Hirsch & Ferrell, Inc., New York, New York: Photo: Fred Weber.

“Without advertising, everybody would think Ronald was just the name of a former president.”

Mike Quinlan, Chairman, CEO McDonald’s (left)

“The remarkable thing is, when you think about McDonald’s® you’ve got to think about people. A friendly crew person welcoming you. Kids, moms and dads having a good time at McDonald’s, even a funny clown named Ronald.® Those pictures in your mind are advertising at work.

Our advertising is people to people—an invitation from our people to our customers to come in and visit. Personal, friendly, and above all, real.

I’m told there are business people out there who don’t believe in the power of advertising. For them, two facts: First, McDonald’s is one of the most advertised brands on this planet. Second, McDonald’s is the only company listed in the current Standard and Poor’s 500 to report combined increases in revenues, income, and earnings per share for more than 100 consecutive quarters since 1965.

Frankly, Ronald and I like to think there’s a connection here.”

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ONE LAST LOOK AT 1993

Before we close the books on 1993, let's take one last look at the developments that made news during the past 12 months. This issue's 1993 Technology Review, written by Advanced Technology Editor Jack Shandle (see p. 18) describes many notable advances in technology that occurred this year. As in the past, throughout the year we selected the most important developments as cover stories. Here's a quick recap of what was featured on Electronic Design's covers in 1993:

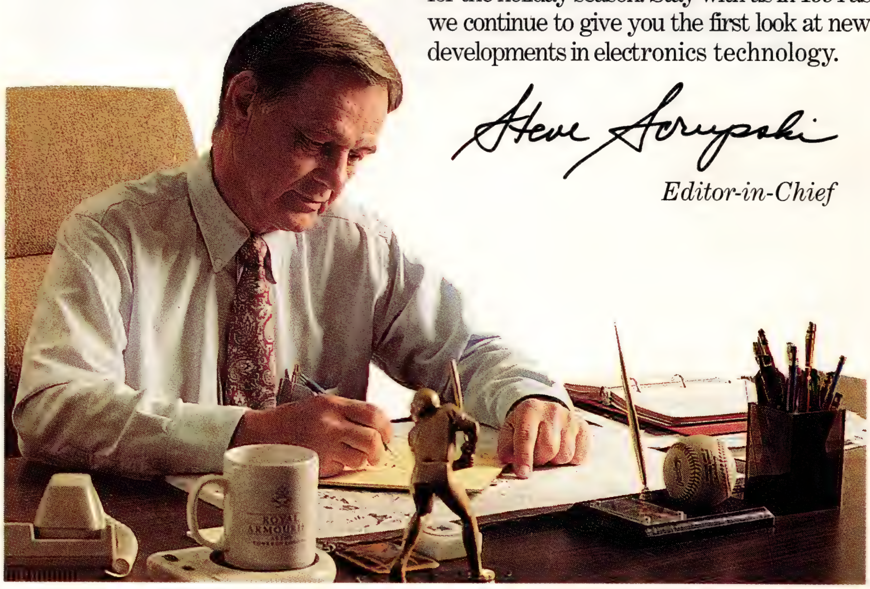
Jan 21	Current-sharing dc-dc converters (Lambda Electronics)
Feb 4	DSP-based disk read-channel ICs (Cirrus Logic)
Feb 18	16-Mbit synchronous DRAMs (Samsung Semiconductor)
Mar 4	Low-cost PC-video compression ICs (Media Vision)
Mar 18	1-MHz PWM switcher controller chip set (National Semiconductor)
Apr 1	Million-gate CPU logic emulator (PiE Design Systems)
Apr 15	Multi-protocol communications ICs (Motorola Semiconductor)
May 3	VLSI behavioral models (Logic Modeling)
May 13	High-performance analog ICs (Micro Linear and Elantec)
May 27	GaAs/CMOS cache-controller ICs (Vitesse Semiconductor)
Jun 10	EMI analysis tools (Racal-Redac and Quantic Laboratories)
Jun 24	Windows accelerator ICs (Oak Technology)
Jul 8	LCD backlight power-control ICs (Unitrode Integrated Circuits)
Jul 22	Digital audio sample-rate converter ICs (Analog Devices)
Aug 5	PCMCIA wireless LAN transceivers (GEC Plessey Semiconductors)
Aug 19	NiCd battery charger IC (Burr-Brown)
Sep 2	Four high-performance op amps (Analog Devices, Burr-Brown, Linear Technology, Harris Semiconductor)
Sep 16	Twisted-pair FDDI transceiver ICs (Micro Linear)
Oct 1	Digital audio decompression ICs (Crystal Semiconductor)
Oct 14	Power 8-bit microcontroller (SGS-Thomson Microelectronics)
Nov 1	Graphics-efficient dual-port DRAM (Samsung Semiconductor)
Nov 11	Laminated-film MCM substrate (Packard-Hughes Interconnect)
Dec 2	Data/fax modem ICs (Silicon Systems)
Dec 16	Complex-PLD Windows-based design toolset (Microsim)

In retrospect, this slate of cover subjects indicates a strong year for technology developments across a broad spectrum, from video and audio compression to power for portable systems.

We thank our readers for their loyal support during 1993 and extend our best wishes for the holiday season. Stay with us in 1994 as we continue to give you the first look at new developments in electronics technology.

Steve Scrupski

Editor-in-Chief



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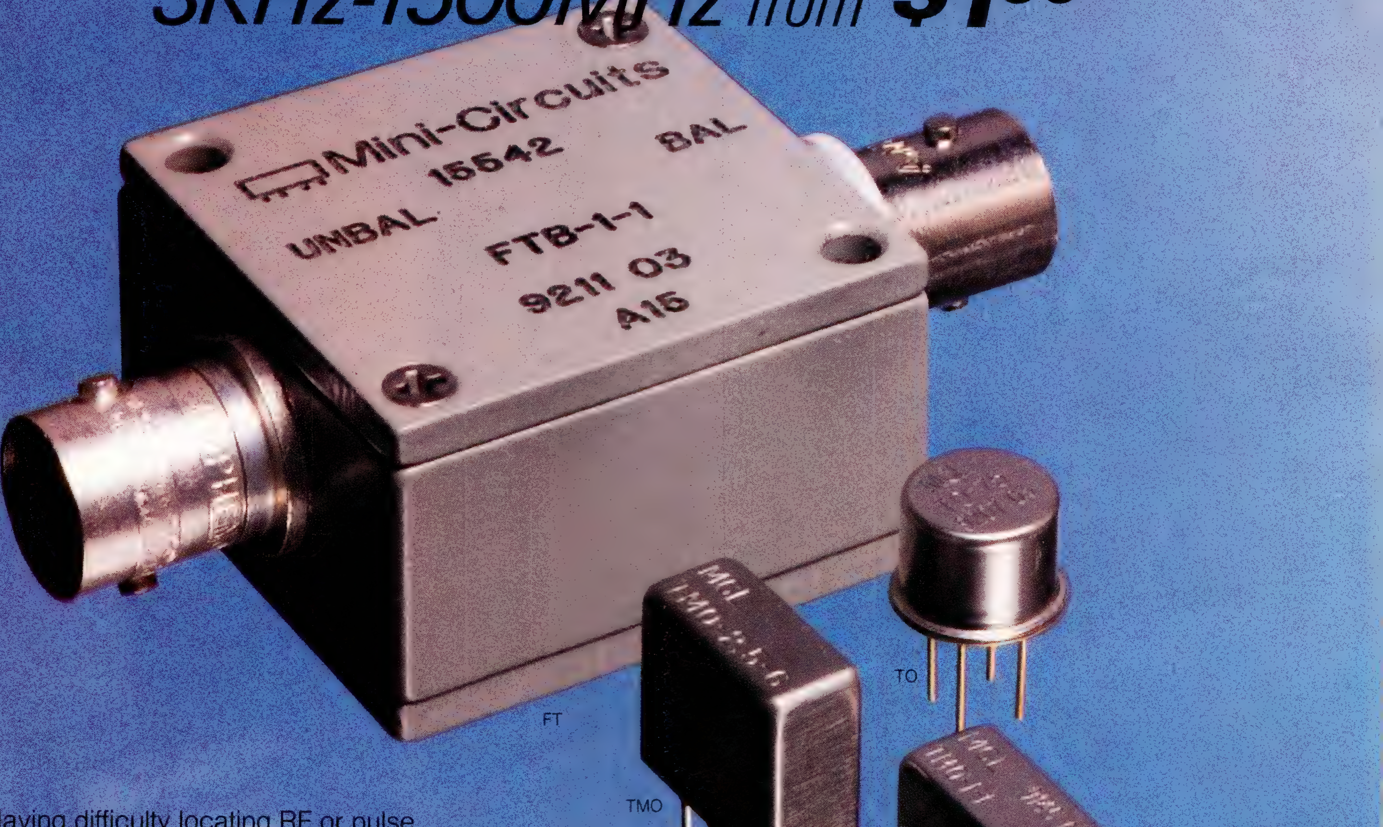

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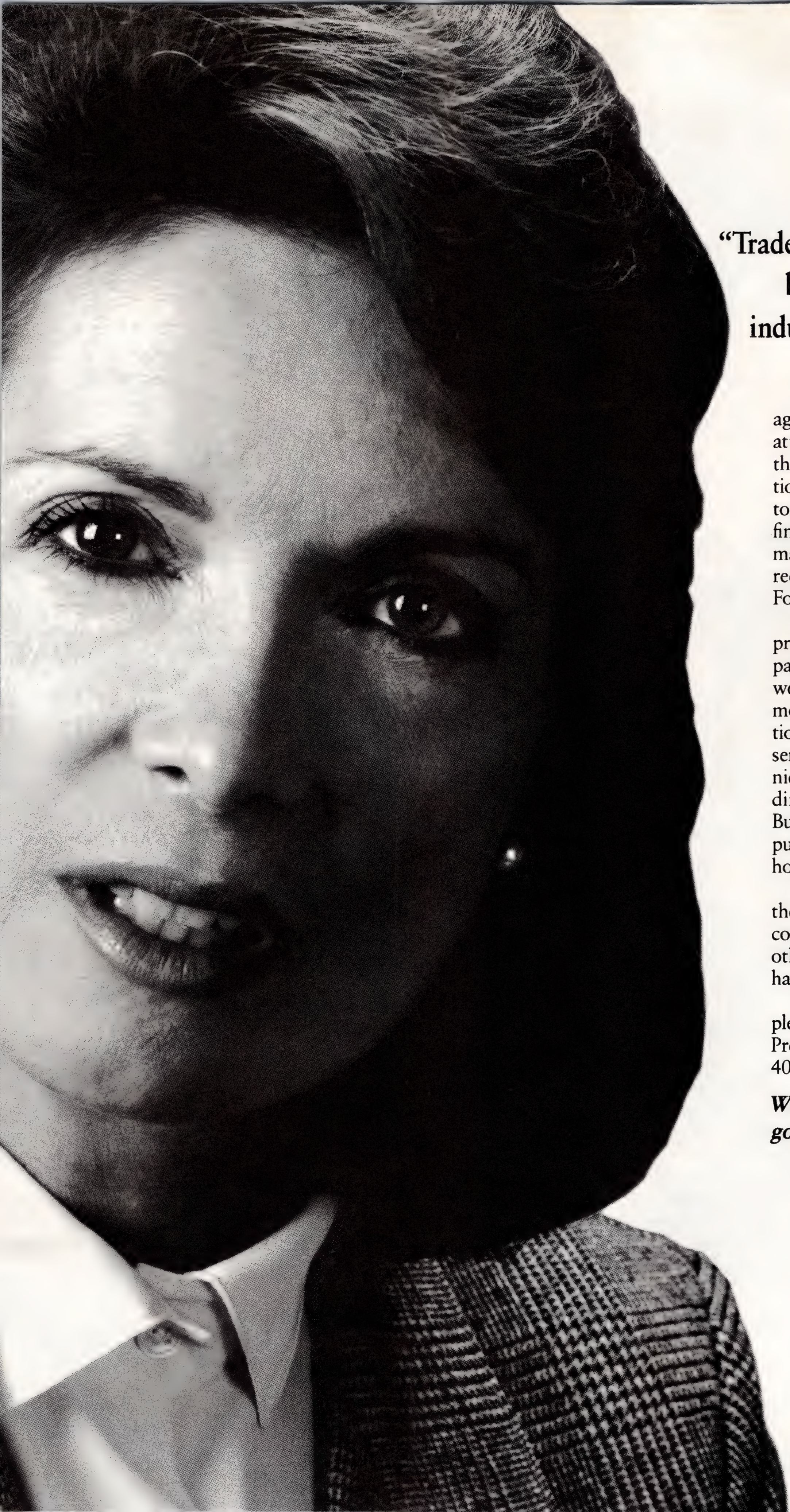

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For a free copy of the study, please write to American Business Press, 675 Third Avenue, Suite 400, New York, NY 10017.

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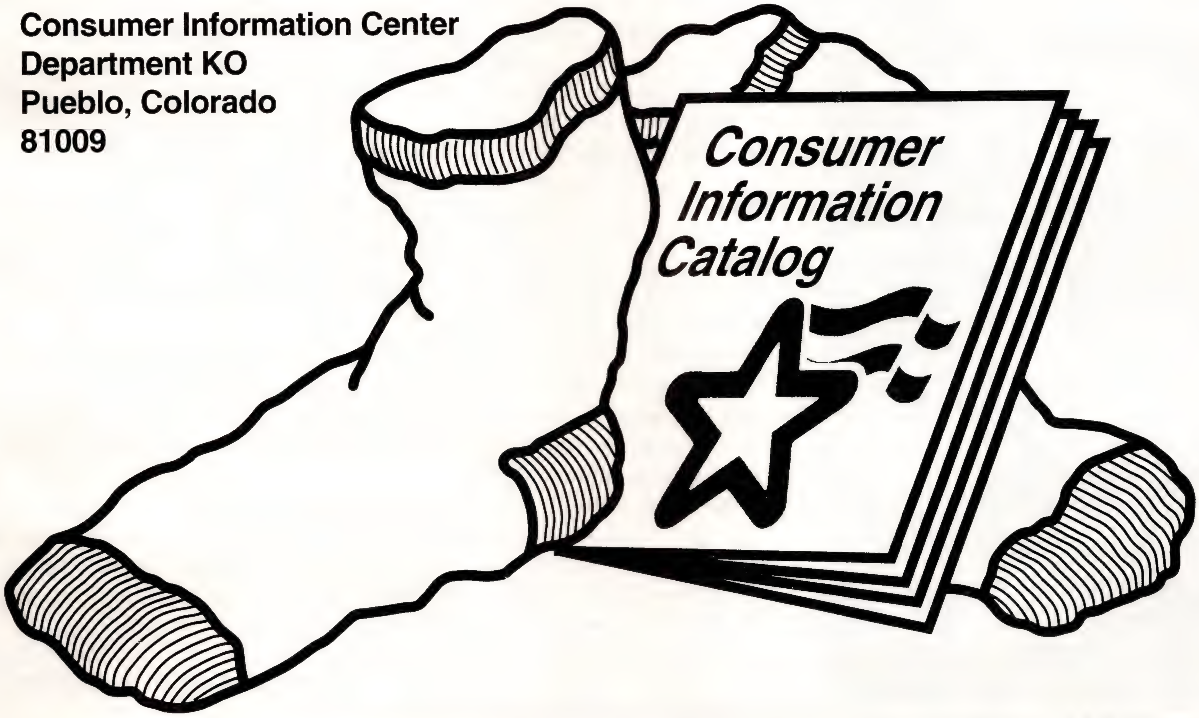

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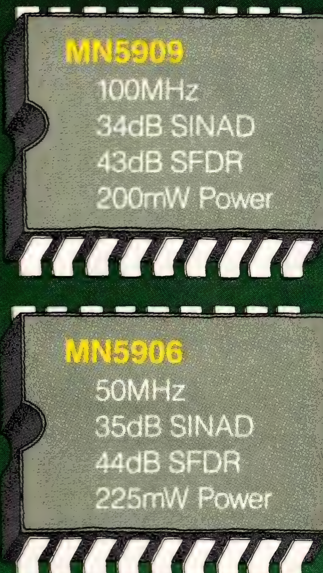

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CIRCLE 106 FOR U.S. RESPONSE
CIRCLE 107 FOR RESPONSE OUTSIDE THE U.S.

THE SIGNS ARE RIGHT FOR DSPs AND PCs

As an editor who first wrote about digital-signal processors migrating onto the motherboard in 1989, I have been watching the smoke signals emanating from Redmond, Wash., for the past six months or so with great interest. If I'm reading those signals correctly, 1994 will be the year that DSPs stake their claim to some space on that valuable square foot of PC real estate.

Shaman Bill's (Gates) blessing is all that is lacking. While there are compelling technical arguments for DSP's being intimately integrated into the PC's basic hardware specification, that could never happen without a strong bridge to Windows. It now seems imminent that Microsoft will announce the availability of a software developer's kit to construct that bridge. It's also safe to bet the ranch on the SPOX DSP operating system from Spectron Microsystems Inc., Goleta, Calif., as Microsoft's choice for handshaking with DOS and Windows.

Four years ago, I concluded that the cost of the DSP chip would have to be well below $10 for the motherboard move to make sense, and that multimedia would be the driving force behind it. I was wrong on the first, but right on the second. Digital-signal processing is just too embedded in the technologies for transforming sound, music, telephony and video to be ignored, and its value far exceeds that $10 threshold. Moreover, there simply are not enough spare MIPS floating around in 80486s to handle real-time, multiple-interrupt functions such as telephony and music synchronization.

JACK SHANDLE
ADVANCED TECHNOLOGIES

The great thing about Windows (as we have often been told) is that it provides a remarkable degree of hardware independence for software applications developers. So Microsoft's DSP API (Application Programming Interface) should enable all the software developers to write code blissfully ignorant of whose DSP chip they are using, right? Not quite. Although DSP chips from Texas Instruments, Motorola, and Analog Devices are covered, other DSP chipmakers are, for the time being at least, left out in the cold. The most notable of these are AT&T Microelectronics, who supplies chips for the Macintosh Quadra 880av and the Centris 660av multimedia computers, and the IBM/TI tandem that sponsors the M-Wave DSP operating system kernel. The reason for this has little to do with Microsoft or its API, but a lot to do with the fact that AT&T and TI's M-Wave team are not yet supported by SPOX.

Microsoft and Spectron will make it as easy as possible for Windows-oriented applications developers, who are, after all, not at the same competency level as embedded systems developers who work with DSPs. As a result, the third-party developers will probably be making the same calls they already do to multimedia services that are executed in software. These will include the sound-synthesis WAVE API, TAPI for telephony and the API for MIDI (Musical Instrument Digital Interface).

SPOX will probably do most of the work here. Microsoft's primary role will be to develop the device drivers on the output side, while Spectron's real-time kernel will schedule and synchronize DSP tasks, and establish communication between tasks by using the normal real-time tools—message queues, mailboxes, and semaphores.

Integrating DSPs into multimedia computing will go a long way towards solving one vexing DSP problem, which is response time. In the early days of multimedia, it was likely that only one DSP-like function would be going on at a time. As we move into the mid-1990s, however, telephony in particular is likely to be running in the background and the modem algorithms such as V.32bis take some considerable number crunching more or less in real time. Add to this video compression or decompression and a couple of audio files being manipulated and hardware is the only answer.

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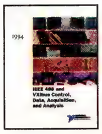

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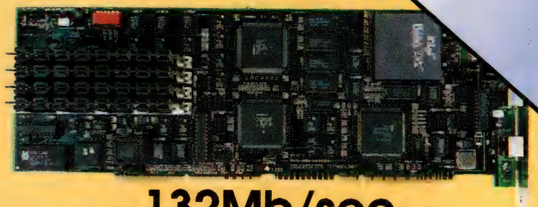

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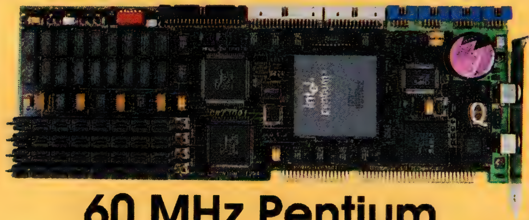

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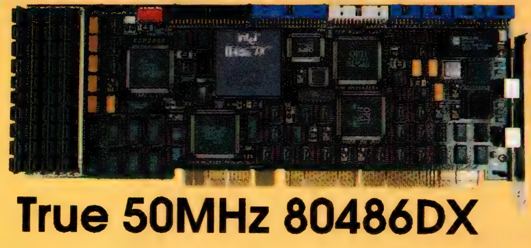

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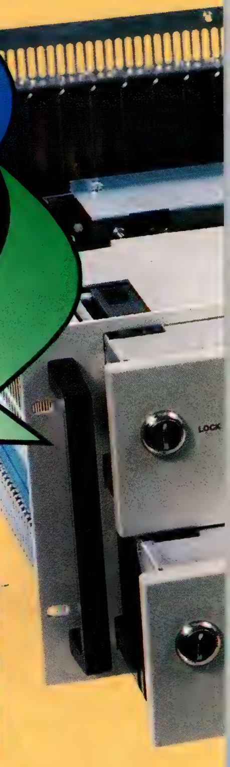

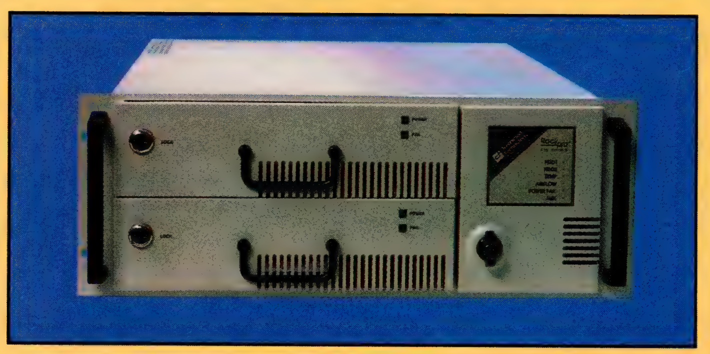

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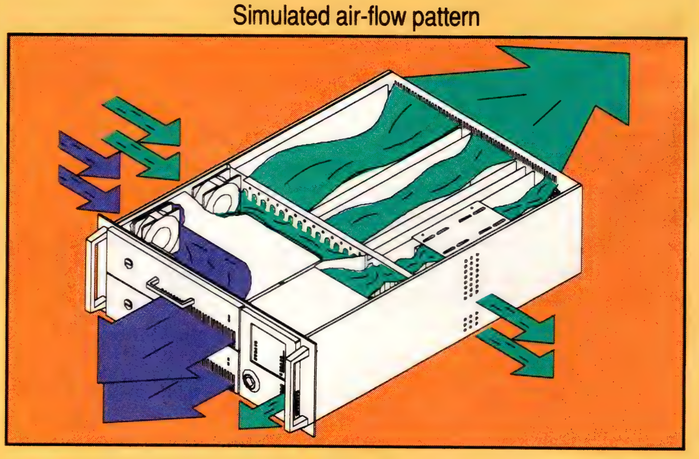

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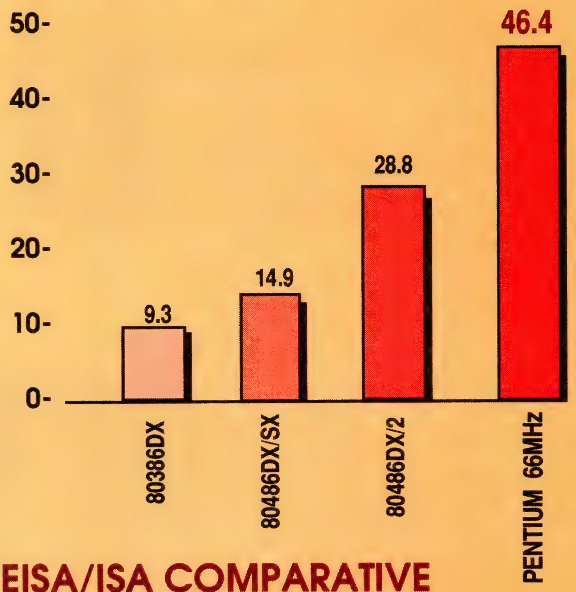

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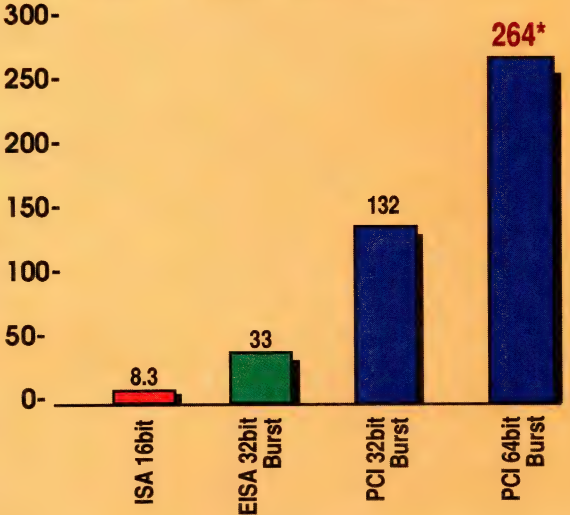

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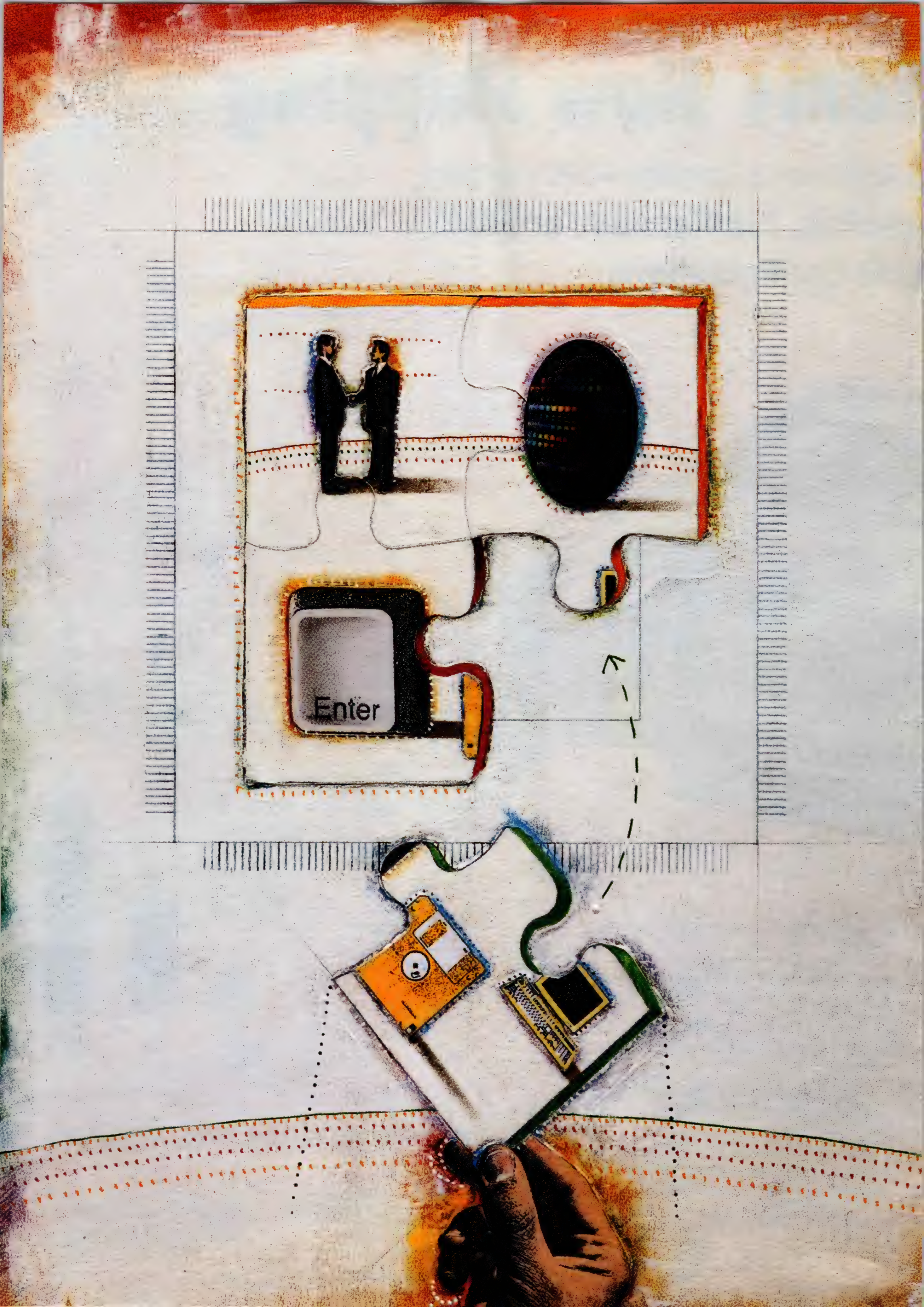
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TECHNOLOGY NEWSLETTER

OPTICAL COATING PUTS 3D IMAGES ON LCDS

A breakthrough in optical coatings has resulted in the development of a plastic film that allows LCD flat panels used in notebook computers or overhead-projection displays to generate 3D images. The film works in conjunction with simple passive-lens glasses and some proprietary software that prepares the images. The film contains a checkerboard-like or one-dimensional array of polarizing elements as small as 20 μm each. A patented process is used to create the array which is fabricated such that its alternating squares in the checkerboard pattern or lines have polarization directions that differ by 90°.

The 3D system, developed by VRex Inc., a subsidiary of Reveo Inc., Hawthorne, N.Y., can be added to either a PC- or Macintosh-compatible LCD-based computer. The coating technology—in development for three years by Reveo in cooperation with the Advanced Research Projects Agency (ARPA), the U. S. Army, the Strategic Defense Initiative (SDI), the Ballistic Missile Defense Operations (BMDO), and the Office of Naval Research (ONR)—promises to lead to a wide range of 3D stereoscopic applications at a relatively low price premium over 2D displays. VRex unveiled at last month's Comdex show a 3D-enhanced notebook computer that sells for about $500 more than an off-the-shelf notebook. In addition, according to the VRex founder Dr. Sadeg Faris, the μPol array coating can also be used to create 3D stereoscopic hard-copy printers that can produce "instant holograms," single 35-mm slides, and 3D overhead transparencies or viewgraphs. The company also developed a 3D stereoscopic camera that can be used to record images for future 3D playback. Standard graphic software packages can also be used to create the basic images, which are then combined with the company's proprietary spatial multiplexing (SMUX) software. For more information, contact VRex at (914) 345-8877. *DB*

SPEC TO FIT VIDEO AND GRAPHICS IN ONE BUFFER

The shared frame-buffer interconnect (SFBI) specification, to be published before the end of the year, defines a method for combining full-motion video, graphics, and other multimedia functions into one integrated subsystem. As a result, full-motion video will appear on a PC platform in a standardized, low-cost configuration. The specification, written by engineers at ATI Technologies, Thornhill, Ontario, and Intel Corp., Santa Clara, Calif., defines a memory organization and arbitration protocol that allows video and graphics to share one memory buffer, thus lowering overall system cost. The SFBI specification also includes ATI's SynchroLink, a technique that permits dedicated controllers in multimedia subsystems to communicate and synchronize time-critical I/Os without intervention from the host CPU. The memory bus specified by the SFBI runs independent of the system bus and can handle uncompressed video data, which can be transferred at a rate of 20 Mbytes/s. For additional information on the SFBI specification, call ATI Technologies at (416) 882-2600. *RN*

BAR-CODE CONVENTION HOLDS MORE DATA

A two-dimensional machine-readable code dramatically improves current bar-code technology. The symbology, called MaxiCode, replaces one-dimensional bar-code labels currently in use. MaxiCode can contain 100 characters of data in an area of 1 in.^{2}. This is considerably more information than found in current implementations. In addition, the information can be read more accurately by the scanner. The MaxiCode technology was developed by United Parcel Service (UPS), Atlanta, Ga., and is being distributed at no charge. Using a camera also developed by UPS, the codes can be read on packages passing at a high speed, at up to 500 ft./min., in any direction and at virtually any angle. An error-detection-and-correction scheme built into the encoding symbology helps to decipher damaged labels. For more information on the MaxiCode symbology, call UPS at (201) 512-4982. *RN*

GRAPHICS INTERFACE EASES ACCELERATOR DESIGN

A technical committee has been formed to develop an advanced graphics interface. This should lower the cost and increase the availability of 2D and 3D graphics hardware for entertainment, game, scientific visualization, CAD, and virtual-reality applications. The interface, which falls under the VESA umbrella, is called the VESA Advanced Graphics Interface—VAGI for short. VAGI is a low-level system-programming interface primarily intended to supply a common high-performance driver in-

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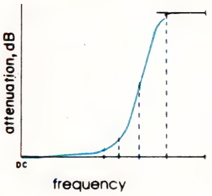
LOW PASS



low pass, Plug-in, dc to 1200MHz

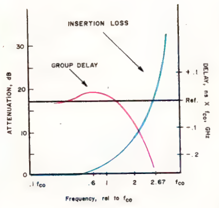
Model No.	Passband MHz loss < 1dB	Stopband, MHz loss > 20dB	Stopband, MHz loss > 40dB
★LP-5	DC-5	8-10	10-200
★LP-10.7	DC-11	19-24	24-200
★LP-21.4	DC-22	32-41	41-200
★LP-30	DC-32	47-61	61-200
★LP-50	DC-48	70-90	90-200
★LP-70	DC-60	90-117	117-300
★P-90	DC-81	121-137	167-400
★LP-100	DC-98	146-189	189-400
★LP-150	DC-140	210-300	300-600
★LP-200	DC-190	290-390	390-800
★LP-250	DC-225	320-400	400-1200
★LP-300	DC-270	410-550	550-1200
★LP-450	DC-400	580-750	750-1800
★LP-550	DC-520	750-920	920-2000
★LP-600	DC-680	840-1120	1120-2000
★LP-750	DC-700	1000-1300	1300-2000
★LP-800	DC-720	1080-1400	1400-2000
★LP-850	DC-760	1100-1400	1400-2000
★LP-1000	DC-900	1340-1750	1750-2000
★LP-1200	DC-1000	1620-2100	2100-2500

Price, (1-9 qty), all models: plug-in $14.95, BNC $32.95, SMA $34.95, Type N $35.95

Surface-mount, dc to 570MHz

Model No.	Passband MHz loss < 1dB	Stopband, MHz loss > 20dB	Stopband, MHz loss > 40dB
SCLF-21.4	DC-22	32-41	41-200
SCLF-30	DC-30	47-61	61-200
SCLF-45	DC-45	70-90	90-200
SCLF-135	DC-135	210-300	300-600
SCLF-190	DC-190	290-390	390-800
SCLF-380	DC-380	580-750	750-1800
SCLF-420	DC-420	750-920	920-2000

Price, (1-9 qty), all models: $11.45

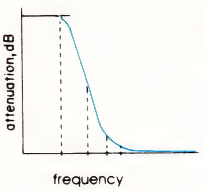


Flat Time Delay, dc to 1870MHz

Model No.	Passband MHz loss < 1.2dB	Stopband MHz loss > 10dB	Stopband MHz loss > 20dB	VSWR Freq. Range, DC thru 0.2fco X̄	VSWR Freq. Range, DC thru 0.6fco X̄	Group Delay Variations, ns Freq. Range, DC thru fco X̄	Group Delay Variations, ns Freq. Range, DC thru 2fco X̄	Group Delay Variations, ns Freq. Range, DC thru 2.67fco X̄
★BLP-39	DC-23	78-117	117	1.3:1	2.3:1	0.7	4.0	5.0
★BLP-117	DC-65	234-312	312	1.3:1	2.4:1	0.35	1.4	1.9
★BLP-156	DC-94	312-416	416	0.3:1	1.1:1	0.3	1.1	1.5
★BLP-200	DC-120	400-534	534	1.6:1	1.9:1	0.4	1.3	1.6
★BLP-300	DC-180	600-801	801	1.25:1	2.2:1	0.2	0.6	0.8
★BLP-467	DC-280	934-1246	1246	1.25:1	2.2:1	0.15	0.4	0.55
▲BLP-933	DC-560	1866-2490	2490	1.3:1	2.2:1	0.09	0.2	0.28
▲BLP-1870	DC-850	3740-6000	5000	1.45:1	2.9:1	0.05	0.1	0.15

Price, (1-9 qty), all models: plug-in $19.95, BNC $36.95, SMA $38.95, Type N $39.95
NOTE: ▲: -933 and -1870 only with connectors, at additional $2 above other connector models.

HIGH PASS

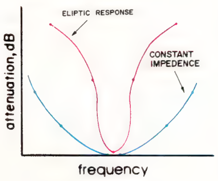


high pass, Plug-in, 27.5 to 2200MHz

Model No.	Stopband MHz loss < 40dB	Stopband MHz loss < 20dB	Passband, MHz loss < 1dB	VSWR Pass-band Typ.
★HP-25	DC-13	13-19	27.5-200	1.8:1
★HP-50	DC-20	20-26	41-200	1.5:1
★HP-100	DC-40	40-55	90-400	1.8:1
★HP-150	DC-70	70-95	133-600	1.8:1
★HP-175	DC-70	70-105	160-800	1.5:1
★HP-200	DC-90	90-116	185-800	1.6:1
★HP-250	DC-100	100-150	225-1200	1.3:1
★HP-300	DC-145	145-170	290-1200	1.7:1
★HP-400	DC-210	210-290	395-1600	1.7:1
★HP-500	DC-280	280-365	500-1600	1.8:1
★HP-600	DC-350	350-440	600-1600	2.0:1
★HP-700	DC-400	400-520	700-1800	1.6:1
★HP-800	DC-445	445-570	780-2000	2.1:1
★HP-900	DC-520	520-660	910-2100	1.8:1
★HP-1000	DC-550	550-720	1000-2200	1.9:1

Price, (1-9 qty), all models: plug-in $14.95, BNC $36.95, SMA $38.95, Type N $39.95

BANDPASS



bandpass, Elliptic Response, 10.7 to 70MHz

Model No.	Center Freq. (MHz)	Passband I.L. 1.5 dB Max. (MHz)	3 dB Bandwidth Typ. (MHz)	Stopbands I.L. > 20dB at MHz	Stopbands I.L. > 35dB at MHz
★BP-10.7	10.7	9.6-11.5	8.9-12.7	7.5 & 15	0.6 & 50-1000
★BP-21.4	21.4	19.2-23.6	17.9-25.3	15.5 & 29	3.0 & 80-1000
★BP-30	30.0	27.0-33.0	25-35	22 & 40	3.2 & 99-1000
★BP-60	60.0	55.0-67.0	49.5-70.5	44 & 79	4.6 & 190-1000
★BP-70	70.0	63.0-77.0	68.0-82.0	51 & 94	6.0 & 193-1000

Price, (1-9 qty), all models: plug-in $18.95,
BNC $40.95, SMA $42.95, Type N $43.95

Constant Impedance, 21.4 to 70MHz

Model No.	Center Freq. MHz	Passband MHz loss < 1dB	Stopband loss > 20dB at MHz	VSWR 1.3:1 Total Band MHz
★IF-21.4	21.4	18-25	1.3 & 150	DC-220
★IF-30	30	25-35	1.9 & 210	DC-330
★IF-40	42	35-49	2.6 & 300	DC-400
★IF-50	50	41-58	3.1 & 350	DC-440
★IF-60	60	50-70	3.8 & 400	DC-500
★IF-70	70	58-82	4.4 & 490	DC-550

Price, (1-9 qty), all models: plug-in $14.95,
BNC $36.95, SMA $38.95, Type N $39.95

NOTE: ★**Add Prefix P, B, N, or S for Pin, BNC, N, or SMA connector requirement.**

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terface for graphics-acceleration hardware. Standardization around one graphics hardware reference model will enable the production of high-volume, low-cost graphics devices, says the organization. Because the VAGI focuses on accelerating fundamental 2D and 3D functions, it can be completely free of applications-programming-interface (API) bias, so multiple graphics APIs and applications can be layered on it without sacrificing performance. To date, work has begun on platforms that run with DOS, Windows 3.1, Windows NT, the Macintosh operating system, and Solaris. For more information, contact the VESA office at (408) 435-0333. *RN*

MCM DESIGN KITS EXPAND SYSTEM'S REACH

The developing multichip-module infrastructure has been bolstered by a series of MCM design-kit announcements. Kits for the High-Density Interconnect (chips-first) technology from the MCM foundry at Texas Instruments, Dallas, and for laminated technology from IBM Microelectronics, Endicott, N.Y., have been introduced by Harris EDA, Fishers, N.Y. for its Finesse MCM Design System. The TI kit contains a comprehensive set of data and system parameters and supports TI's Open Foundry concept for its HDI process. Users of the IBM kit can exploit the advanced capabilities of IBM's Endicott foundry. Harris EDA has also developed a universal design kit for MCMs that enables designers to select from low-temperature cofired-ceramic, silicon, laminate chip-on-board, or the TI HDI technologies. For more information on the MCM design kits, call Harris at (716) 924-9303 for information. *DM*

HOT-SWAPPING BOARDS IS GETTING EASIER

The insertion of a board or adapter card into a digital bus while it's operating can easily disrupt the bus's operations, particularly with today's fast processors and short cycle times. But engineers at IBM Corp.'s laboratories in Research Triangle Park, N.C., have come up with an elegant solution. The basic concept behind the recently patented invention is to partially charge up the capacitance in an unpowered signal net on the board to be inserted. The reason "live insertion" is disruptive is that the board's capacitive load is in an uncharged state. By adding a resistive voltage charger circuit to the board logic, the transient load to the system is minimized. Besides the addition of board logic, the technique's primary requirement is that power and ground connections are made before the active signal nets are connected. There are many obvious applications for a live insertion technology, not the least of which is PCMCIA cards that are plugged into portable equipment. Local area networks are another application. For more information on the technique, call Frank Pita at (919) 254-0767. *JS*

EMBEDDED TOOL SUPPLIERS JOIN FORCES

Developers of real-time and embedded systems often piece together development tools and operating systems from several vendors, with mixed results. However, the recent merger of Microtec Research, Santa Clara, Calif., and Ready Systems, Sunnyvale, Calif., opens up the possibility of an integrated design environment from the initial design of an embedded system to the debugging of code. Microtec Research's cross and native compilers, assemblers, and XRAY source-level debuggers accelerate software development and hardware integration of embedded applications. Ready Systems is responsible for the VRTX real-time operating system and the Spectra cross-development backplane. The merger is expected to be complete by year's end. For more information, call Dan Jaskolski at (408) 980-1300. *SVT*

SRAM PROCESS BUILDS 3-V HDD READ CHANNEL

As the pressure grows on hard-disk drive makers to mix smaller size and lower power with higher data-transfer rates, designers are looking at the read channel as one place to attack these "conflicting" needs. With that in mind, Motorola's Linear Bipolar Div., Tempe, Ariz., modified a 1-μm, biCMOS SRAM process to build the lowest-power and smallest read-channel IC. Running off a supply rail between 2.7 and 5.5 V, the MC34244 needs just 400 mW of power (at 3.3 V) and handles data at 48 Mbits/s. Its over 22,000 transistors crammed into a tiny 64-pin TQFP are about equally divided between analog and digital tasks. The threshold voltage of the nMOS and pMOS FETs was optimized for operation at low voltage. The bipolar transistors are used for the high-performance front-end analog signal-processing circuits. These include the AGC amplifier, the tunable g_m/C filter biquads, as well as critical timing and phase-locked-loop circuits. The CMOS FETs are used in microprocessor-interface logic and the encoder-decoder, as well as on biasing circuits, current sources, buffers, and level shifters in the AGC amplifier. To eliminate the need for space-eating external coupling capacitors, the front end is dc-coupled. For additional information, call (602) 897-3615. *FG*

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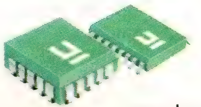

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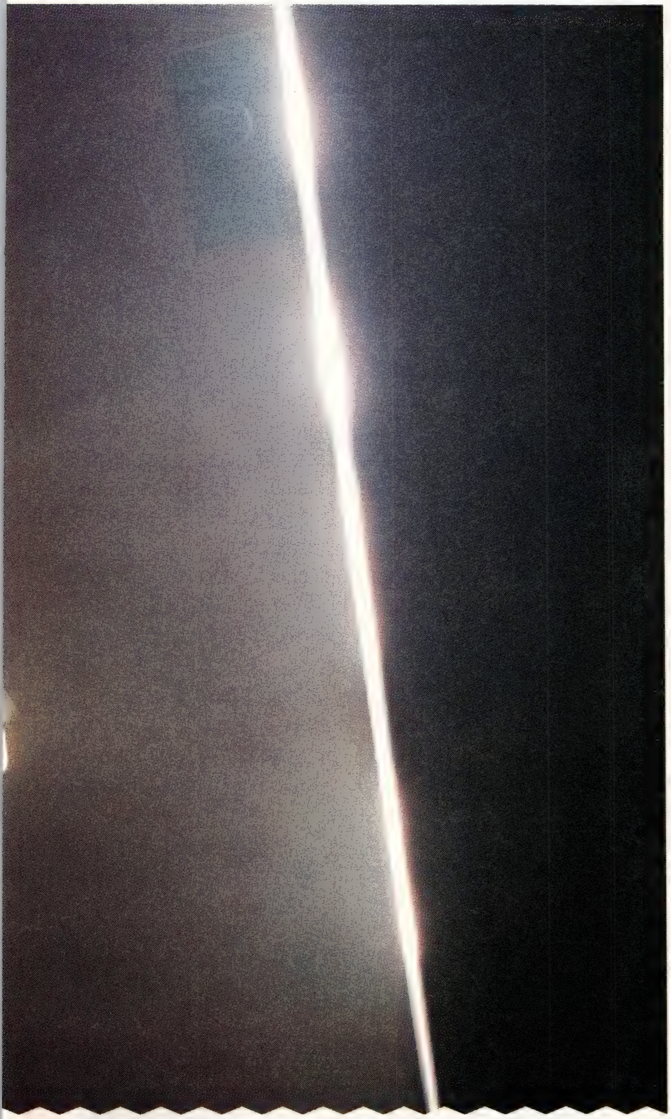

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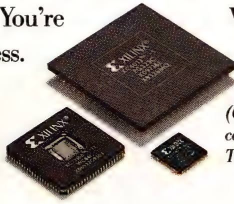

(Clockwise from left) Our XC7300 EPLD for PAL conversion, our new 13,000 gate XC4013 FPGA, and a TQFP, one of our more than 250 packaging options.

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CONFERENCE PREVIEW

PORTABLE BY DESIGN CONFERENCE COVERS THE GAMUT OF PORTABLE SYSTEM DESIGNS

JACK SHANDLE

The Portable By Design Conference, to be held in the Santa Clara, Calif., Convention Center from Feb. 14-18, 1994, will focus on the technical challenges and solutions of designing portable equipment of all types and applications. Besides being one of a very few conferences addressing portable products, it's the only one that tightly focuses on technical issues, as opposed to marketing or end-user concerns.

Portable By Design, organized by *Electronic Design*, comprises 13 sessions, which will encompass multiple engineering disciplines. Two four-hour sessions will address critical mechanical, ergonomic, and industrial design issues, while the other 11 sessions will provide insights into various electronics topics, such as digital ICs, power management, power circuits, battery technology, connectivity, and PCMCIA. Two sessions will concentrate on software: One will bring together for the first time the proponents of the leading operating systems designed for portable products; the other will address the specific problems of developing applications for portable products—and the impact of software-applications requirements on hardware design.

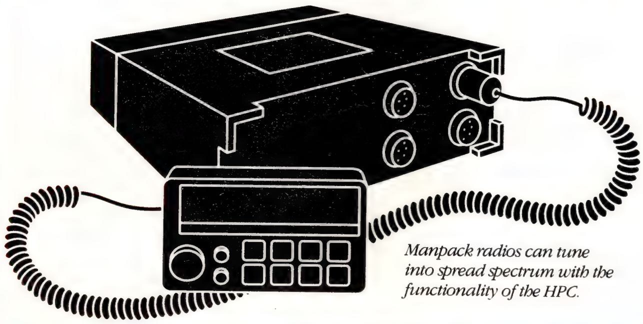
Recognized experts in many fields will deliver papers and serve as chairpersons for the sessions. For example, analog guru Jim Williams, staff scientist at Linear Technology Corp., Milpitas, Calif., will deliver a paper on "Techniques for 92% Efficient LCD Illumination." In addition to the presentation, Williams has written a lengthy applications note that will appear for the first time in the conference proceedings.

Other presenters include Paul Gulick, chief technical officer of Motif Inc., Wilsonville, Ore., who will speak on Motif's unique, power-efficient LCD technology that allows active addressing of passive displays. Bob White, director of PCS Services and Architecture for Bellcore, Red Bank, N.J., will describe the telecommunications infrastructure being planned by the telephone companies and explain how best to design for it. Tony Requist, vice president of engineering, GeoWorks Inc., Berkeley, Calif., plans to speak on the design and implementation of an operating system for portable products. Requist was the primary architect of the Geos operating system that runs the recently introduced Sharp PT-9000 PDA

WHY PRODUCTS FAIL

The mechanical sessions have sparked a high level of interest because mechanical and ergonomic features often spell the difference between a successful and unsuccessful product. Dennis Boyle, a senior design engineer at IDEO Product Development, Palo Alto, Calif., will chair the sessions. Boyle, who is also a consulting professor at Stanford University, specializes in the mechanical and industrial design of various handheld consumer products, notebook and subnotebook computers, medical instruments, and telephone equipment. He was the project leader of the recently released Duo-Dock notebook computer for Apple Computer Inc.

Portable By Design has also considered engineers' needs to get up to



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speed fast on certain critical design challenges of portable products. Five tutorial workshops have been set up with experts in their respective fields. The subjects of the workshops are: accelerated product development; design and implementation of dc-dc converters for battery-powered applications; designing for internal and external interference problems, including EMI, RFI, and ESD (electrostatic discharge); regulatory issues for portable systems that will be marketed in the European Community; and a workshop on ergonomics.

The ergonomics workshop will be conducted by Boyle and a colleague, Jane Fulton Suri, director of Human Factors Engineering at IDEO. According to Boyle, they're planning an interactive tutorial with "in-session exercises" and a short break with "ergonomically correct snacks." The topics they will cover include: anthropometrics; safety issues and agency standards; human/computer interface design; user testing for design validation; and a case study using a high-profile product now on the market.

The accelerated product-development workshop will be conducted by Ori Koppelman, president of a consulting firm in Palo Alto, Calif. An experienced project leader, Koppelman served for three years as chairman of the IEEE's Engineering Management Society in the Silicon Valley. As important as time-to-market is in developing virtually any electronic product in today's global economy, the importance is magnified for portable products. Their very nature tends to have a consumer-oriented product lifespan.

"Sluggish product development can cost companies thousands of dollars of lost profits per day due to late entry into the market," says Koppelman. "Consider the fact that 60% of Hewlett-Packard's revenue comes from products introduced in the last two years. To survive in a leapfrog world, you must learn to develop products swiftly."

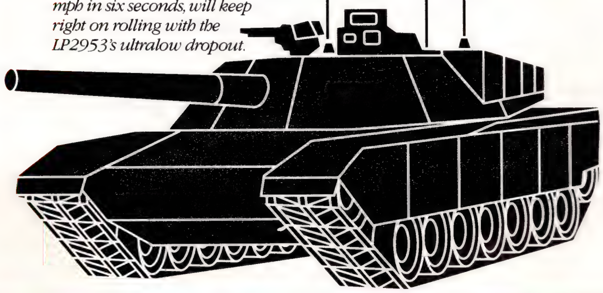
Koppelman will address the problems and solutions of initiating quality rapid product development through such topics as: trying to do too much in one project; the not-invented-here syndrome; and the need for a working prototype early in the schedule.

DESIGN-ORIENTED

Two of the workshops will take a highly detailed, design-oriented approach. Eric Persson, president of Analog Circuit Design Corp., Minnetonka, Minn., will focus on designing dc-dc converters. To design an energy-efficient portable product, engineers have found that they must abandon the more familiar linear-regulator power-supply technology for switching power supplies. Although more efficient, switching power supplies require greater attention to design details, says Persson. His workshop will address many of these issues including: an overview of common topologies; selecting a topology to match the application; designing, selecting, and specifying magnetic components; factors contributing to efficiency; thermal management; sources of noise and EMI; proper pc-board layout of power converters; and testing and troubleshooting converter circuits.

The other designer-oriented tutorial will be conducted by Bill Kimmel, a principal of Kimmel Gerke Associates Ltd., St. Paul, Minn. Kimmel's course will address a topic of high importance for portable products: eliminating all types of interference from designs. "This is not just another general introductory course about grounding or shielding for EMI, and it is not a course in regulations and testing," says Kimmel. "It is a seminar that concentrates on design and troubleshooting techniques for achieving self-compatibility and compatibility with neighboring environments."

For more information on attending the conference, call *Electronic Design* at (201) 393-6075.



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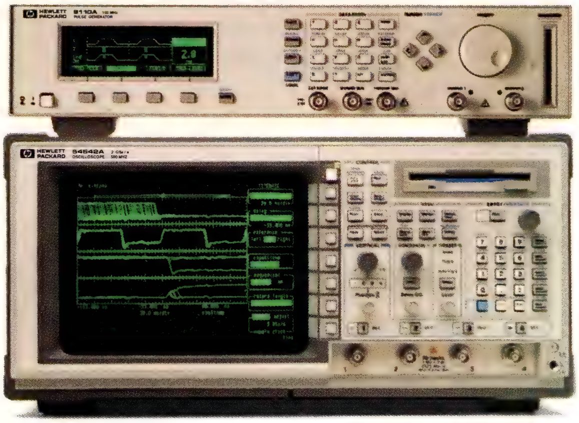

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CIRCLE 98 FOR U.S. RESPONSE

CIRCLE 99 FOR RESPONSE OUTSIDE THE U.S.

A SUITE OF UNIQUE CIRCUITS PROTECT 100-W IC AUDIO AMPLIFIERS FOR CONSUMER SYSTEMS

Often, ideas put forth by electronic designers last long after they're gone. One such case involves the late legendary analog-IC designer Bob Widlar. He deeded to National Semiconductor a suite of protection circuits that enabled the company to develop a family of unique and virtually indestructible IC audio power amplifiers for consumer applications. The amplifiers provide output power to 100 W *(see the figure)*.

Widlar's suite of circuits are called Self Peak Instantaneous Temperature Ke, or SPiKe (Ke stands for Kelvin). They protect the amplifiers from damage due to instantaneous temperature peaks, overvoltage, undervoltage, output shorts to the supply rail or ground, and thermal runaway.

Consumer electronic equipment must be reliable and rugged—it must take significant abuse—and audio power amplifiers are no exception. Such amplifiers are found in mainstream applications ranging from compact and component stereos to TV and car radios.

Until now, semiconductor power amplifiers (whether discrete, hybrid, or IC) attained safe-operating-area (SOA) protection by adding external resistors that provide adjustable current limiting, which also limits maximum current output. The SPiKe circuits, on the other hand, sense the output-transistor's temperature, kicking in at about 250°C. Depending on the amplifier's operating conditions at that time, the SPiKe circuits reduce the output-drive transistor's base current, keeping it within the required SOA.

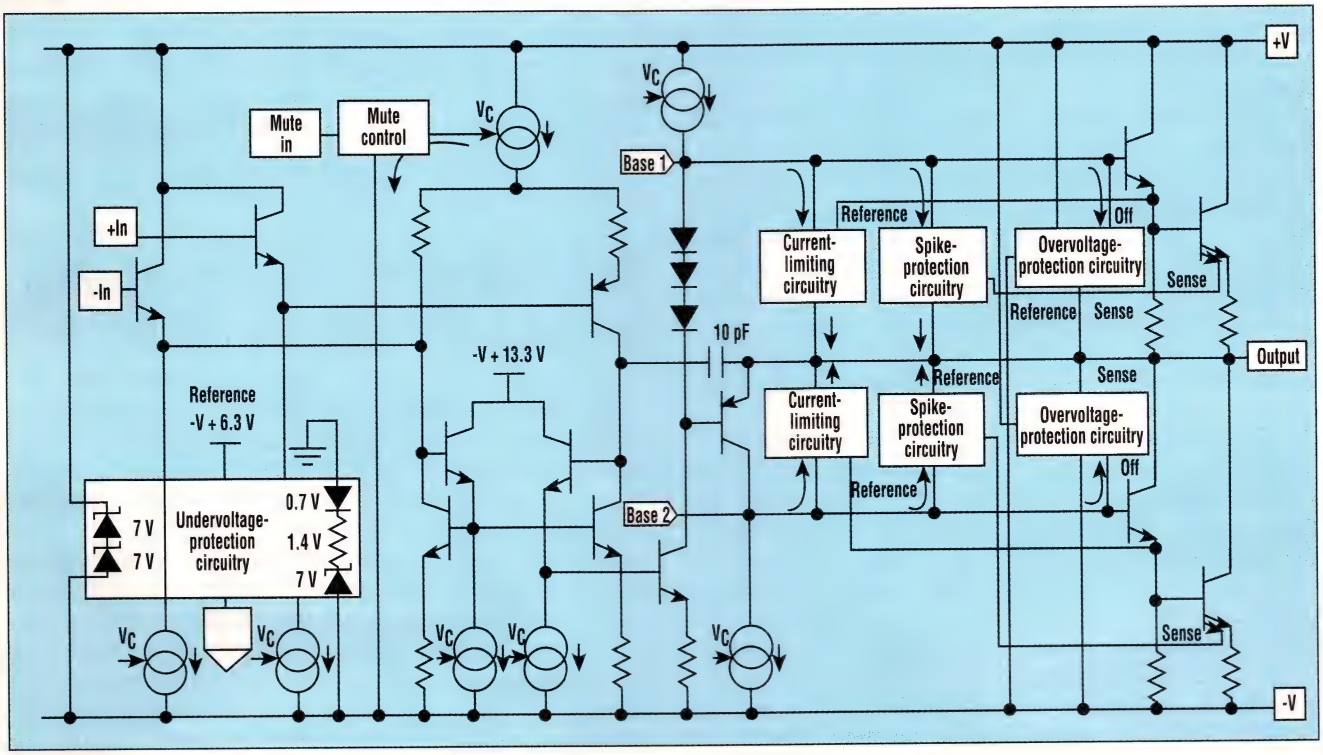
For example, a SPiKe circuit automatically protects the IC from the high output load imposed by a short circuit to ground. Such a short can occur if the speaker is incorrectly connected to the output after power is applied. The result is usually a component failure, an angry system user, and ultimately a warranty that must be handled by the system builder.

The protection circuit, a sophisticated form of current limiting, lowers the current limit when the amount of time it's used increases. When the IC is in the current-limiting mode, the temperature of the output-drive-transistor array is allowed to rise, as time passes, to a maximum of 250°C. At that time, the instantaneous temperature-limiting circuitry cuts in lowering the current limit.

The current-limit circuit monitors the current in the output transistor. When it senses an increase in output-transistor current, it reduces the base current to the drive transistor. The harder the input tries to drive the output, the lower the base-drive current provided. In addition, as the supply voltage increases during current limiting, the turn-on point for the SPiKe circuit decreases. Thus, because the internal power dissipation is now greater, the output drive transistor will reach its SOA sooner.

The protection circuits shut down the amplifier when any overtemperature conditions exist. Though power ICs have featured thermal-shutdown protection circuits for a number of years, SPiKe circuits employ a unique scheme in which individual cells forming the output transistors are protected dynamically from hot-spot formation—a common failure mode for IC power amplifiers. The technique takes care of failure from overvoltage high-thermal loads caused by system malfunctions, as well as high-temperature environments.

The undervoltage pro-


+V
Mute in
Mute control
VC
VC
Base 1
Reference
Off
Current-limiting circuitry
Spike-protection circuitry
Overvoltage-protection circuitry
Sense
Reference
Sense
+In
-In
10 pF
Output
-V + 13.3 V
Sense
Reference
Reference -V + 6.3 V
Current-limiting circuitry
Spike-protection circuitry
Overvoltage-protection circuitry
Off
Reference
0.7 V
7 V
Undervoltage-protection circuitry
1.4 V
7 V
7 V
Base 2
VC
VC
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-V

ED/COTAFG26/ONLY FIG.

tection circuit, a first for audio amplifiers, basically protects the user's eardrums and the speakers. In most amplifiers, as internal biasing is established during power-up, the output stage is relatively unstable and popping noises are heard (these noises can annoy the listener, and stress the speakers, and in extreme cases destroy them). The protection circuits, along with a user-controlled mute input, eliminate such noises.

While the amplifier's bias currents are being established, the "pop-cutting" circuits disable the output, putting it in a high-impedance state by cutting off all of the chip's current sources via internally-developed control signal V_C *(see the figure, again)*. V_C won't let the current sources function until the total supply voltage between the positive and negative rail is greater than 14 V, or until the negative rail is at least –9 V. The mute circuit holds the amplifier's output at ground.

Audio amplifiers also need protection against the high-voltage flyback spikes created by sudden changes in current flowing in an inductive load, such as a speaker. When a push-pull amplifier goes into power-limit (SOA) conditions as it drives an inductive load, the inductor drives the output beyond the supply rail. The resulting voltage spike may exceed the output-transistor's breakdown voltage, thus destroying it. Protection for such transients requires costly Zener or Schottky diodes from the output to each supply rail.

However, a SPiKe circuit in these push-pull IC amplifiers (National's Overtrue family) senses that the output voltage has exceeded a supply rail, immediately turning the driving output transistor off so as not to exceed its breakdown voltage. The circuitry continues to monitor the output, waiting to turn the transistor on when the overvoltage fault ceases. While monitoring the output, the instantaneous overtemperature circuits may also kick in, particularly for lower-frequency waveforms that have a smaller SOA.

These amplifiers possess an internal supply clamp, a Zener diode. They also have a diode drop from the output to the positive supply rail and an intrinsic diode drop from the output to the negative rail. The result is an 8-V clamp to the positive rail and an 0.8-V clamp to the negative rail.

Contact National's Peter Himes at (408) 721-7517 or (800) 727-9959.

FRANK GOODENOUGH

IC CHIP SET PACES OPTICAL NETWORK TRIALS

A small British firm has come up with a set of semiconductor ICs that together form a complete multiplexer-demultiplexer and cross-connect system. The chips will be used in 2.54-Gbit/s STM-16 synchronous digital hierarchy (SDH) as well as synchronous optical-network (SONET) transmission systems. Swindon Silicon Systems Ltd. (SSSL) designed the nine chips as its contribution to a project funded under the European Commission RACE advanced communications R&D program. The goal of the program is to develop a high-capacity optical network (HCON) for the customer premises.

SSSL director Clive Bunney says that the system can handle data at an aggregate rate of 40 Gbits/s. A prototype system has already been built to prove the practicality of the project. And, with new funding for the second phase of the RACE program, a complete demonstration system is now under construction. The project is being led by the British Broadcasting Corp.

The HCON makes use of a wave-division multiplexing (WDM) technique, where lightwaves at 16 different wavelengths are carried on a single optical fiber strand. Each lightwave features a wavelength of 4 nm and carries data at the SDH STM-16 rate of 2.54 GHz. SSSL's chips multiplex, demultiplex, switch, and condition electronic signals before and after they're converted to and from their optical form.

The chip set includes input and output buffer ICs, a 2.5-GHz multiplexer and demultiplexer, an STM-1 clock-recovery circuit, and a byte multiplexer. The set also incorporates an STM-16 to STM-1 demultiplexer that splits out data streams contained within a 2.54-Gbit/s channel into 16 data streams, each at a rate of 155 Mbits/s, as well as an STM-1 adapter.

A key device is the 12-by-12 switching matrix, virtually a full 2.54-Gbit/s crossbar-switch core on one chip. The switch is fully nonblocking and can pass a full-bandwidth 2.5-Gbit/s data stream from any input port to any combination of the 12 output ports. "Bigger switches can be made simply by adding more chips," explains Bunney. As a result, a 48-by-48-port crosspoint switch matrix can be built by interconnecting 16 of the chips.

The SSSL chips will reach the open market during the last quarter of this year and the first quarter of 1994. Samples and evaluation prototypes of five of the nine chips are available now.

For more information, contact Swindon Silicon Systems Ltd., Radnor Street, Swindon, Wiltshire, SN1 3PR, United Kingdom. Telephone: +44 (0)793 614039.

PETER FLETCHER

BUFFER SPEC STANDARDIZES SIGNAL-INTEGRITY MODELS

As digital-system designers continue to confront higher clock speeds and advanced packaging techniques, signal-integrity simulation becomes imperative. Consequently, achieving effective simulation demands early access to accurate models. That shouldn't be a problem, though, thanks to an emerging signal-integrity standard called the I/O Buffer Information Specification (IBIS), which is intended to ensure that models are available when required by engineers. IBIS was developed by a group of electronic-design-automation (EDA) and semiconductor vendors known as the IBIS Open Forum. The vendor group includes Cadence Design Systems, In-

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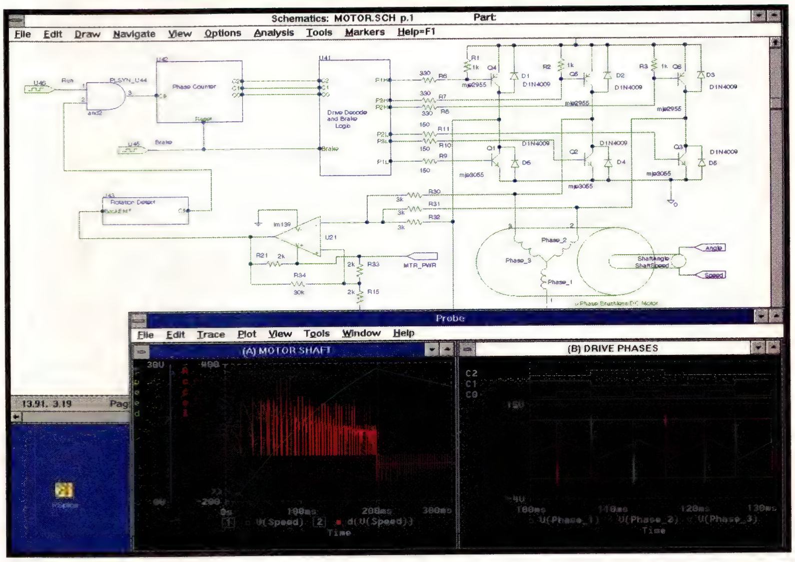
Polaris automatically extracts parasitics from board layouts and applies transmission line, parasitic capacitance, and coupling values, back to the circuit. After simulation, the circuit's behavior can once again be verified, comparing waveforms showing the effects of crosstalk, reflection, and delay, to the ideal waveforms.



Schematics: MOTOR.SCH p.1
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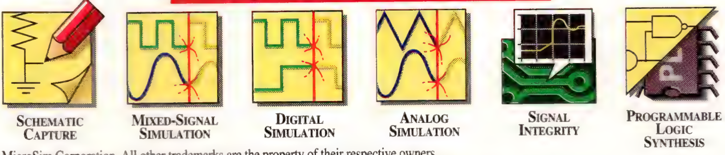

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IBIS is a consistent format that semiconductor vendors use to specify the analog characteristics of input and output buffers. This information is then readily transformed into accurate models by both end users and simulation-tool vendors. By using the resulting behavioral models, engineers can perform high-speed, accurate signal-integrity simulations of their own digital-system interconnections.

Today, most I/O-buffer model development is based on actual circuits. Such descriptions reveal detailed information about not only the buffer design, but also underlying, proprietary fabrication processes. In contrast, the IBIS model uses a circuit's voltage-versus-current (V-I) characteristics, along with additional circuit, package, and timing information, to describe the buffers. This form of data protects the semiconductor-vendor's proprietary design and process-technology information while still offering a useful, accurate model for engineers.

The data used to develop an IBIS model is easily derived from simulations of actual circuits or measured directly using commonly available laboratory equipment. This data includes V-I curves for high- and low-output transitions; V-I curves for clamp diodes; component capacitance values; and per-pin package resistance, inductance, and capacitance values.

By simplifying data collection and removing proprietary issues, semiconductor vendors can provide IBIS models prior to, or concurrently with, the availability of the first available components.

Simulation speed is another benefit derived from IBIS. Because IBIS models are behavioral, simulations run much faster than corresponding structural models. In fact, the Open Forum claims that speed improvements of 25 times aren't uncommon. The IBIS model accomplishes this performance improvement without sacrificing accuracy by incorporating the specification of many nonlinear effects of the I/O design, including package parasitics and forward-biased ESD-protection diode effects.

Intel and the IBIS development group have been working for a year to refine the specification, benchmark the resulting models, and verify the simulations from the models against laboratory measurements of actual circuits. Intel recently developed and released the first IBIS models for the 82420 and 82430 PCIset components, which operate at up to 66 MHz.

Although initially focused on CMOS processes, the IBIS Open Forum is taking steps to broaden the specification into other technologies and circuits, such as ECL devices and open-collector outputs. Because these extensions should be relatively easy to incorporate, they're expected to be added quickly. By mid-1994, the group intends to develop a comprehensive standard that can be taken to the standards community for formal adoption. The forum is actively seeking additional participation to support the expansion, especially from semiconductor developers and system designers.

For more information about the IBIS Open Forum, send an e-mail request to ibis-info@vhdl.org; or call Karen Kirkpatrick, Cadence Design Systems, at (508) 262-6448.

LISA MALINIAK

NANOCRYSTALS PROMISE SMALLER AND FASTER CHIPS

A new class of crystalline material discovered by academic researchers could lead to dramatic reductions in IC size. Scientists at the University of Georgia in Athens have created stable molecules called nanocrystals that consist of ordered frameworks of less than 100 atoms. As a result of this new method, crystals can virtually be grown to any size or shape.

The process used by Dr. Michael Duncan and graduate student Jeffrey Pilgrim at the UGA chemistry department is similar to the one that led to the discovery of buckminsterfullerene, which has come to be known as buckyballs because of their spherical shape. In the UGA experiment, titanium was irradiated by a laser until it vaporized. When the titanium vapor was mixed with methane, the nanocrystals contained 14 titanium atoms and 13 carbon atoms.

"This is an entirely new way to grow crystals," claims Duncan. He adds that "they could be grown to the size and shape needed, for instance, to pack a computer on a chip."

Employing nanocrystals in computer chips could be important. But just as interesting is their possible use as reaction catalysts.

The properties of structures so small are unknown, so it's not certain that they will react as semiconductors or conductors. "We really don't know how the material behaves when it's so small," says Duncan. "Will it still act as a conductor or a semiconductor when it's that small? We're still trying to determine the size, shape, and stability of these molecules."

Duncan's work deals with molecules called clusters, which are created by exposing materials to intense laser heat in a vacuum. The laser breaks down the chemical properties of the target, and a puff of material known as a "molecular beam of clusters" results. This airborne material can then be combined with another element (such as carbon) and extracted for study. The masses are measured in a "time-of-flight" mass spectrometer.

Duncan was working with a family of metal-carbon clusters called metallo-carbohedrenes, or "met-cars," when he came across the nanocrystal structures. Met-cars, discovered by Dr. A. Welford Castleman Jr. of Pennsylvania State University, are relatively stable cage-shaped structures, leading researchers to suspect that they would be useful in producing electronic or catalytic materials.

Duncan and Pilgrim have experimented with titanium, vanadium, and zirconium met-cars, all of which were first studied by Castleman. Other experiments involved chromium, iron, and molybdenum.

Contact UGA's Office of Public Information at (706) 542-8501.

JACK SHANDLE

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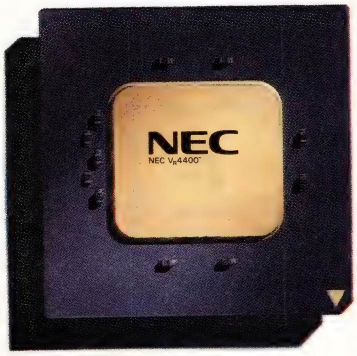

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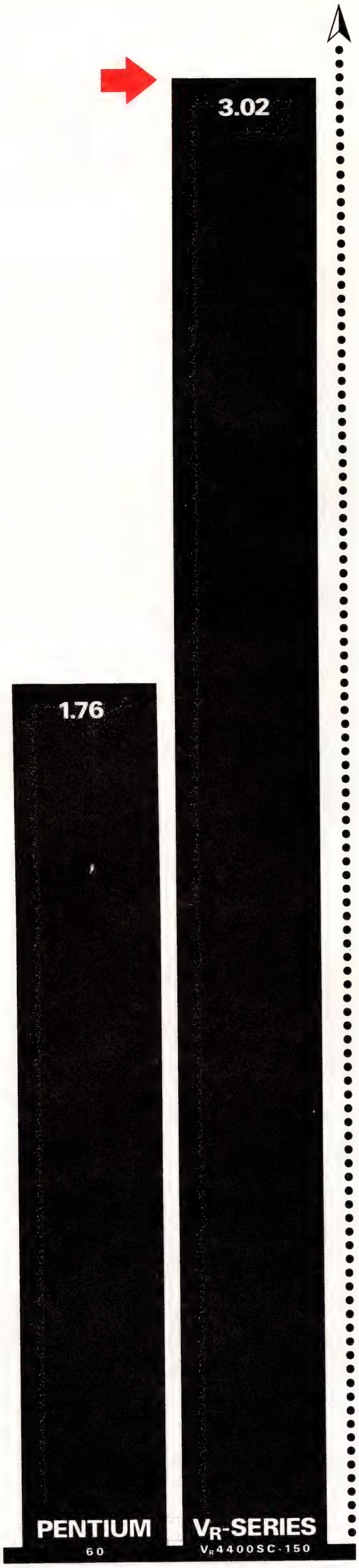

BYTE BENCHMARK
PERFORMANCE RELATIVE TO 486-66

NEC

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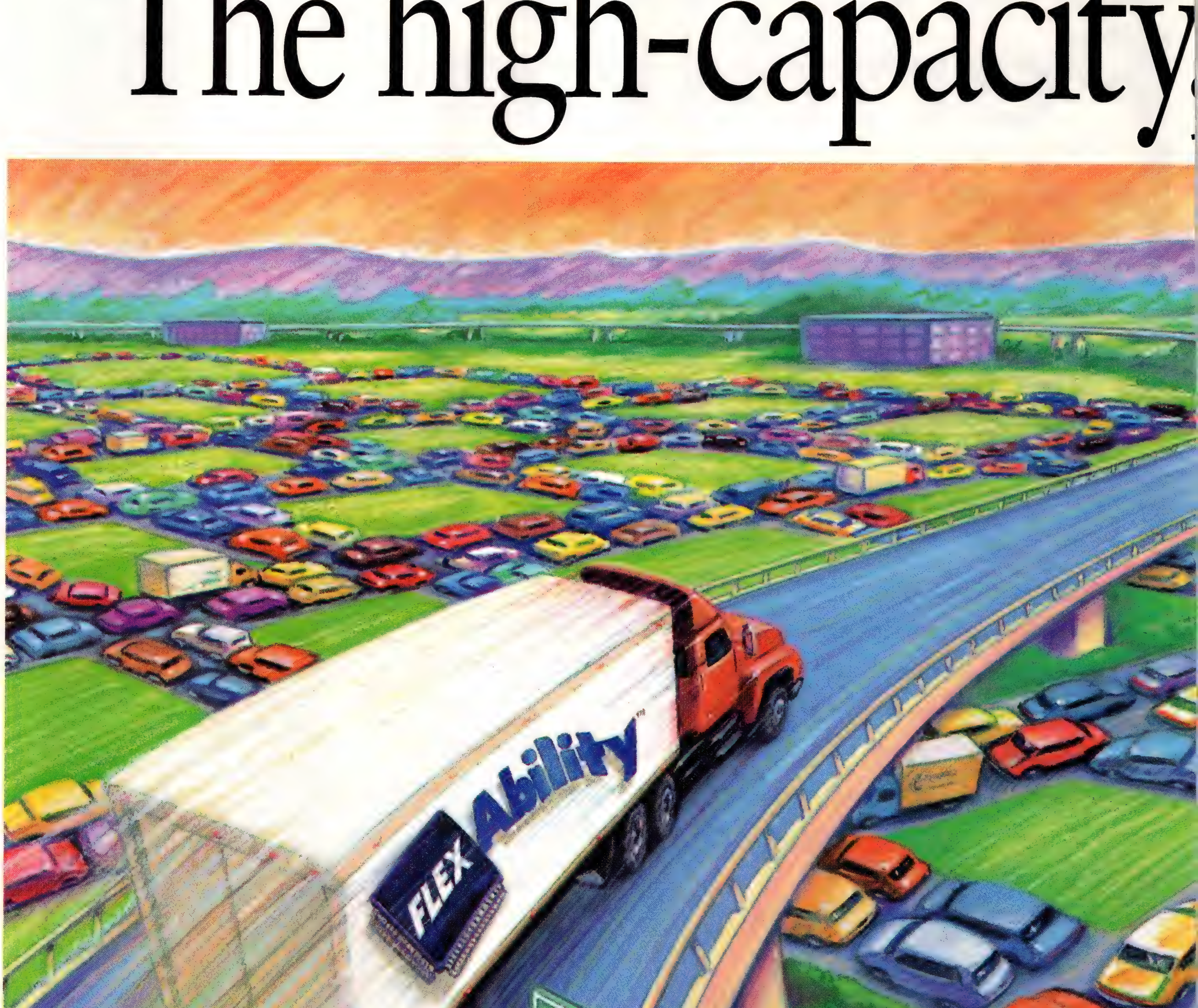
CIRCLE 203 FOR U.S. RESPONSE

CIRCLE 204 FOR RESPONSE OUTSIDE THE U.S.

The high-capacity



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igh-speed highway.

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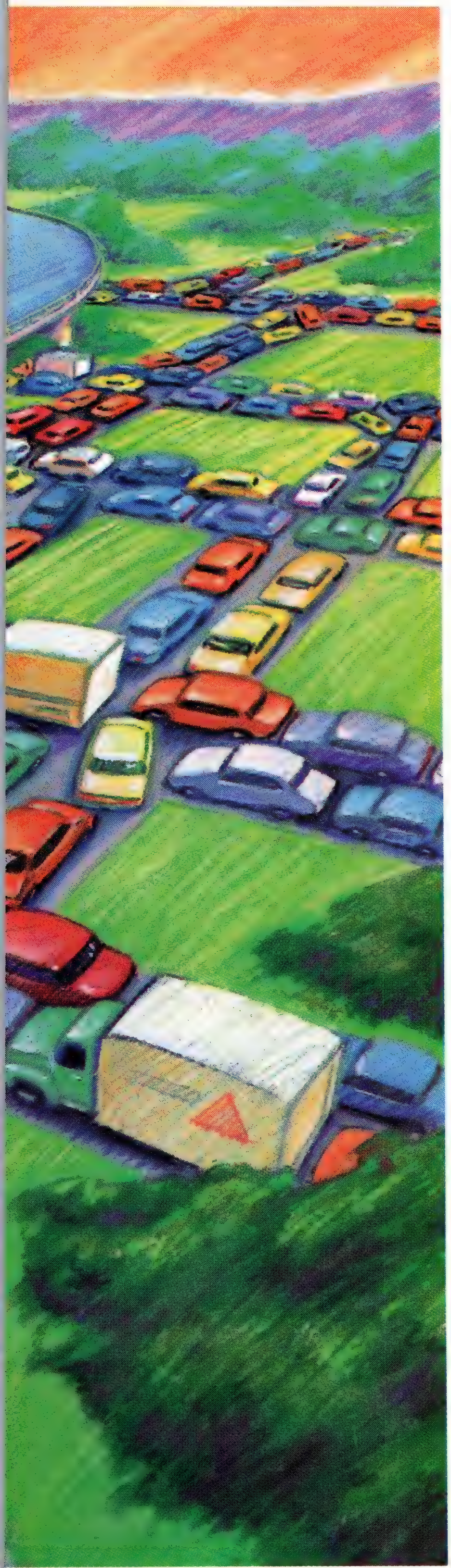

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WINDOWS-BASED TOOLSET SYNTHESIZES COMPLEX PLDs

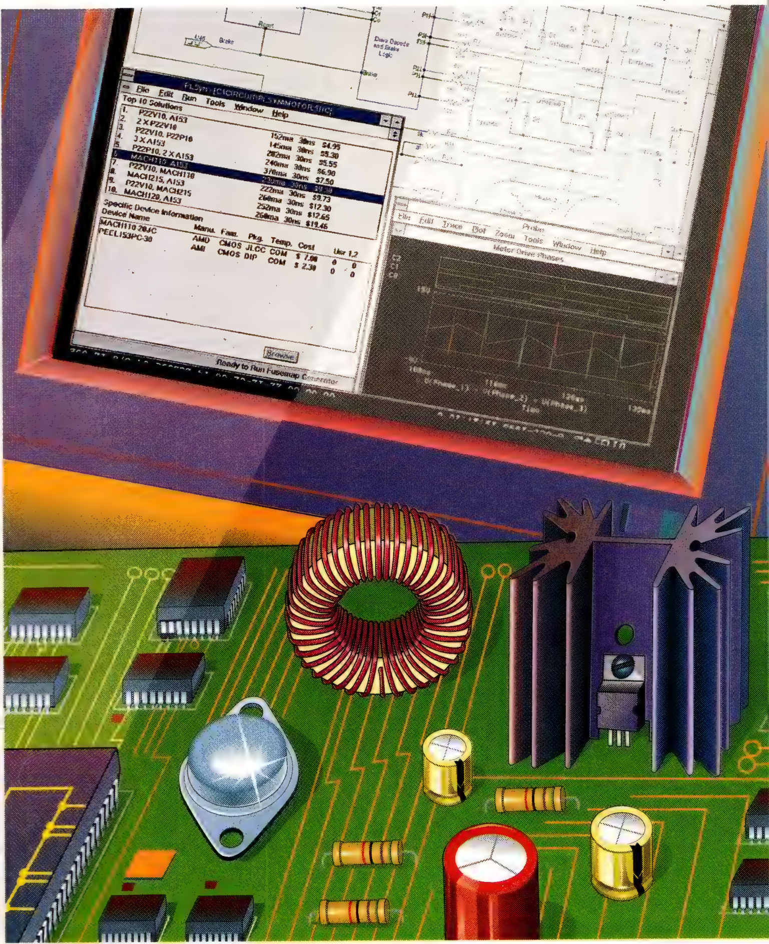
LISA MALINIAK

Engineers are quickly discovering that programmable logic offers numerous benefits—shorter design cycles, faster time to market, and reduced product costs, just to name a few. However, the devices alone can't fulfill these promises. First-rate design tools are key to exploiting the productivity hidden within programmable integrated circuits.

In particular, complex programmable-logic devices (CPLDs) are becoming increasingly useful. With capacities of several thousand gates, they let engineers consolidate a great deal of random logic into just one or two parts. Package count, power, and board space are greatly reduced, while speed is increased. And complex PLDs don't require manufacturer-specific layout software.

To address the need for quality PLD and CPLD design tools, MicroSim Corp. created the PLSyn programmable-logic synthesis system for desktop computers. As a part of the company's Design Center mixed-signal design environment, it combines device-independent, mixed-level design capture; min-max timing simulation; optimized logic synthesis; and automated goal- and constraint-directed device selection under the Microsoft Windows user interface *(Fig. 1)*.

PLSyn automates the physical implementation phase of the design process, while still providing users with as much control over details as desired. A graphical interface lets users specify physical design constraints and device-selection goals. Consequently, engineers can complete designs quickly, without having to learn the details of all the available programmable-device architectures. At the same time, they have control over any details



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6.	MACH110, A153	[illegible]	[illegible]	[illegible]
7.	P22V10, MACH110	222ma	30ns	$9.73
8.	MACH215, A153	268ma	30ns	$12.30
9.	P22V10, MACH215	252ma	30ns	$12.65
10.	MACH120, A153	268ma	30ns	$19.46

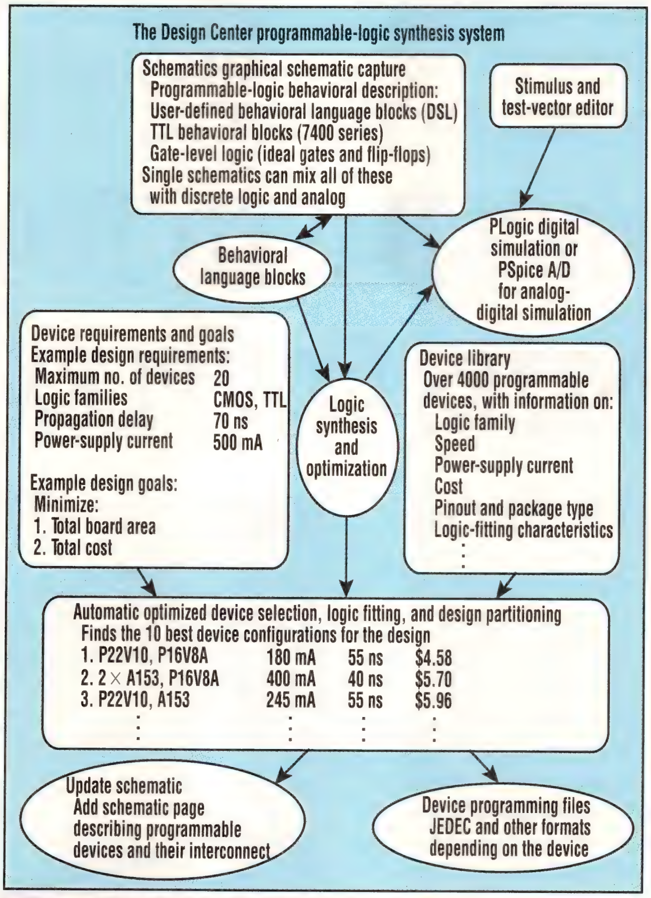
Specific Device Information

Device Name	Manu.	Fam.	Pkg.	Temp.	Cost	Usr 1,2	
MACH110-20JC	AMD	CMOS	JLCC	COM	$ 7.98	0	0
PEEL153PC-30	AMI	CMOS	DIP	COM	$ 2.30	0	0

Ready to Run Fusemap Generator

of the physical implementation that may be required for the final product (such as pin assignments).

The PLSyn environment is particularly suited to two large groups of users. The first is engineers consolidating random pc-board logic into one CPLD. In the past, TTL was the traditional way to implement simple control logic. PLDs can replace some of this, but until recently, they've been on the small side and their architecture has been limited. The new complex PLDs (1000 to 5000 gates) are big enough to collect lots of random logic together in one chip.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User-defined behavioral language blocks (DSL)
TTL behavioral blocks (7400 series)
Gate-level logic (ideal gates and flip-flops)
Single schematics can mix all of these
with discrete logic and analog
Stimulus and test-vector editor
Behavioral language blocks
PLogic digital simulation or PSpice A/D for analog-digital simulation
Device requirements and goals
Example design requirements:
Maximum no. of devices 20
Logic families CMOS, TTL
Propagation delay 70 ns
Power-supply current 500 mA
Example design goals:
Minimize:
1. Total board area
2. Total cost
Logic synthesis and optimization
Device library
Over 4000 programmable devices, with information on:
Logic family
Speed
Power-supply current
Cost
Pinout and package type
Logic-fitting characteristics
Automatic optimized device selection, logic fitting, and design partitioning
Finds the 10 best device configurations for the design
1. P22V10, P16V8A 180 mA 55 ns $4.58
2. 2 × A153, P16V8A 400 mA 40 ns $5.70
3. P22V10, A153 245 mA 55 ns $5.96
Update schematic
Add schematic page describing programmable devices and their interconnect
Device programming files
JEDEC and other formats depending on the device

1. THE COMPONENTS of MicroSim's PLSyn programmable-logic synthesis system help provide a smooth flow from design entry through implementation. With this environment, programmable logic can be designed within the context of the system design.

The second group involves engineers using microcontrollers and firmware. For the last 20 years, microcontrollers handled control jobs too complex for TTL. For jobs in which a microcontroller is overkill, CPLDs are just large enough to implement some of the control functions. And CPLDs are faster than microcontrollers.

Several factors distinguish PLSyn as a first-rate programmable-logic design environment. First, it's important for engineers to create programmable designs within the context of the whole board. With PLSyn, a PLD or complex PLD can be specified, synthesized, and simulated as part of a larger design, not in a vacuum. In addition, there's no need to switch between software packages when designing the rest of the circuit because the Design Center can even handle analog components.

For example, engineers can select which portions of a schematic to pack into CPLDs, and which to leave as TTL. The trade-offs between current-drive requirements, pinout limitations, cost, and board area usually aren't obvious. Often, the only way to decide where the boundary should be is to quickly try out a few different combinations. The PLSyn environment is set up to accommodate that type of design style.

Also, a significant benefit of PLSyn is that it runs under Microsoft Windows, which has had an enormous effect on the PC-based EDA world. Windows users benefit from the graphical, easy-to-use interface and the level of compatibility with other Windows applications. In addition, Windows runs on low-cost desktop platforms.

With the design-capture capabilities of PLSyn, users have the flexibility to mix language-based and graphical definitions of programmable logic on the same schematic with both analog and discrete digital components. The board or system can be designed as a whole, and its operation can be verified before users need to think about the physical implementation required for the programmable logic. Engineers are able to focus on the system being designed, not the available design tools or parts to build it. The result is a productivity increase.

MicroSim's schematic-capture program, called Schematics, is a front-end tool that lets engineers create a design, simulate it, view the results, and make improvements without leaving the schematic-drawing environment *(Fig. 2)*. Multi-page hierarchical design support offers multiple views. Engineers can isolate parts of the design into blocks, and only work with the inputs and outputs of the blocks in the top-level schematic. This allows them to focus on the design's architecture, rather than the implementation details. Double-clicking on the block brings up its internal schematic or behavioral-language description for viewing or editing.

Schematics allows a block to have more than one detailed description, or view. By using two views, an engineer can keep both a behavioral description of a bandpass filter, for example, and a transistor-level implementation. In addition, a full range of interactive schematic-editing features include general component attribute handling; cutting, copying, and pasting between pages and schematics; autorepeat with stepping; and rubberbanding of wires and buses. An integrated symbol editor lets users add to or modify the more than 9000 symbols supplied with the Schematics software without exiting the schematic editor.

PLSyn combines the Design Center's simulation, interactive stimulus-entry, and waveform-viewing programs with its own programmable-logic synthesis capabilities. Either the PLogic or PSpice A/D simulator can be used. Both have the same logic-simulation features, but PSpice A/D adds all of the analog simulation capabilities of PSpice in a mixed-signal simulator.

Users don't need to do anything special to include programmable logic in a PLogic simulation. If a schematic incorporates programmable-logic devices or blocks of the company's Design Synthesis Language (DSL), then the programmable-logic design compiler will be run before simulation to translate these elements into logic equations (and find any DSL errors). PLogic will include the compiled logic equations in the simulation. The logic is simulated

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without delays because the implementation isn't yet known. Upon completion of the physical design process, PLogic will employ real device delays and the optimized, device-specific logic equations, yielding a system-level timing simulation.

The PLogic simulator contains five logic levels (0, 1, rising, falling, and unknown) and 64 strengths. For min-max timing verification, PLogic can run a single simulation that locates timing problems for any possible combination of actual device delays. This catches many more errors than simply simulating with all devices at max delay, and again with all at min delay.

Users benefit from the efficient logic modeling that results from the gate and flip-flop models being built into the simulator. Boolean equations also can be used to describe the function of a logic block. In addition, detailed pin-to-pin delay and constraint modeling is available, along with traditional gate and flip-flop delays. Timing errors, such as setup and hold violations, are graphically displayed to the engineer.

PSpice A/D is tightly integrated with Schematics to support mixed-signal simulation without any special effort from users. Analog and digital devices can be mixed on the schematic in any way the design requires. Then, PSpice A/D will create the appropriate interfaces between analog and digital, and do the simulation. The analog and digital waveform display systems are also integrated, so the engineer isn't required to learn any new tools to display analog and digital waveforms in the same window.

The waveform and analysis tool is called Probe. Probe is a graphical tool that supports multiple windows and multiple simulation runs simultaneously. It's fully integrated with Schematics, so engineers can point to a trace on the schematic and view the simulation results for it. Also, complex arrangements of traces and axis ranges can be named and stored for quick re-display on another simulation, and multiple cursors allow for exact timing measurements. Finally, analog and digital traces can be displayed on a common time axis as the simulation proceeds.

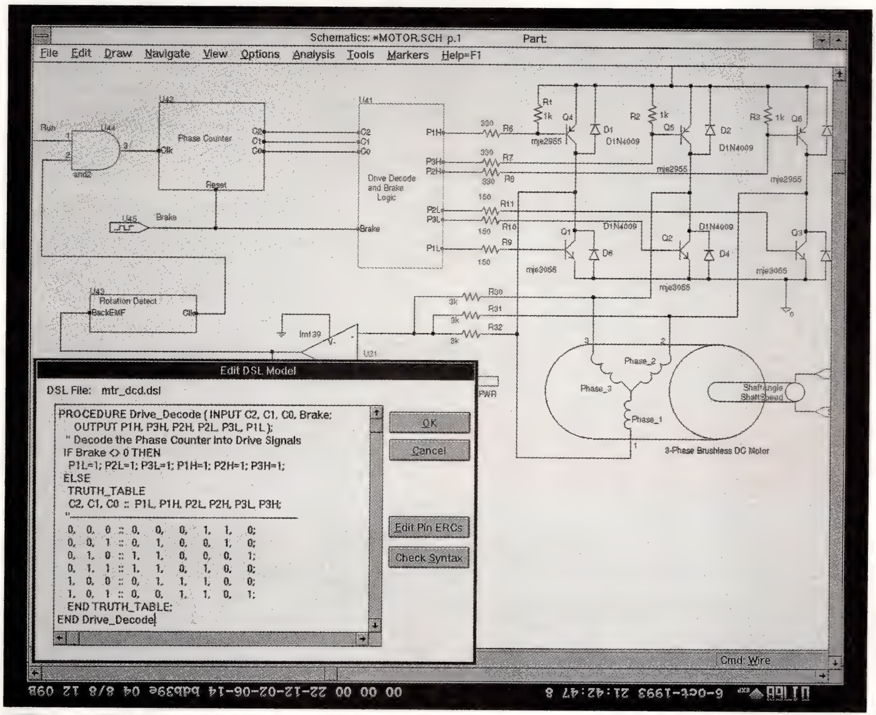
PLSyn's logic synthesis, device library, device selection, and design-partitioning capabilities are derived from the PLDesigner-XL software created by MINC, Colorado Springs, Colo. MicroSim came up with a new graphical user interface for the PLDesigner-XL product, and then integrated it with the company's Design Center family. As a result, although the capabilities provided by the complete system are new to the marketplace, the synthesis, library, selection, and partitioning engines are proven technology.

With PLSyn, users describe the behavior of their system independently from any device architecture using high-level constructs like arithmetic expressions or state machines. The logic is optimized and synthesized for the device architectures that are chosen later. This optimization contains both global and device-specific components, and results in efficient implementations.

The logic optimization includes user-controllable node collapsing, which allows high-level language constructs, such as arithmetic operators, to be used while maintaining an efficient physical implementation. It also includes full exclusive-OR and multiple register-type synthesis. PLSyn creates logic equations for D, JK, RS, and T flip-flops so that the designs can be placed in any type of device. "Don't care" states are handled throughout optimization to ensure optimum design representation for device fitting. Automatic device-specific optimization and synthesis allows the engineer to ignore the device architecture during the functional and logic design, but still obtain an efficient physical design.

The device-selection and design-partitioning section of PLSyn clearly reveals the benefits of device-independent programmable-logic design. This is where the engineer's physical design requirements (package type, speed, power consumption, etc.), the behavioral design definition (synthesized and optimized), and the list of devices considered by the engineer are all combined *(Fig. 3)*.

Using a patented process, PLSyn partitions the design (if necessary) into pieces that fit efficiently into one or more programmable devices. And the system doesn't stop when it finds the first configuration of devices that hold the design: PLSyn continues evaluating alternatives until it finds the ten best device con-



```
PROCEDURE Drive_Decode ( INPUT C2, C1, C0, Brake;
   OUTPUT P1H, P3H, P2H, P2L, P3L, P1L );
 " Decode the Phase Counter into Drive Signals
 IF Brake <> 0 THEN
  P1L=1; P2L=1; P3L=1; P1H=1; P2H=1; P3H=1;
 ELSE
  TRUTH_TABLE
  C2, C1, C0 :: P1L, P1H, P2L, P2H, P3L, P3H;
 "______________________________________________
  0,  0,  0 :: 0,   0,   0,   1,   1,   0;
  0,  0,  1 :: 0,   1,   0,   0,   1,   0;
  0,  1,  0 :: 1,   1,   0,   0,   0,   1;
  0,  1,  1 :: 1,   1,   0,   1,   0,   0;
  1,  0,  0 :: 0,   1,   1,   1,   0,   0;
  1,  0,  1 :: 0,   0,   1,   1,   0,   1;
  END TRUTH_TABLE;
END Drive_Decode
```

2. THE DECODER MODEL that appears in the lower left of the screen is described with MicroSim's Design Synthesis Language and a truth table. This model describes the drive decode and brake logic block shown on the schematic.

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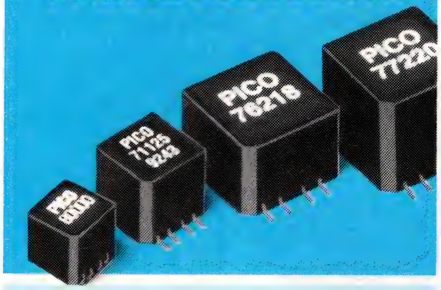

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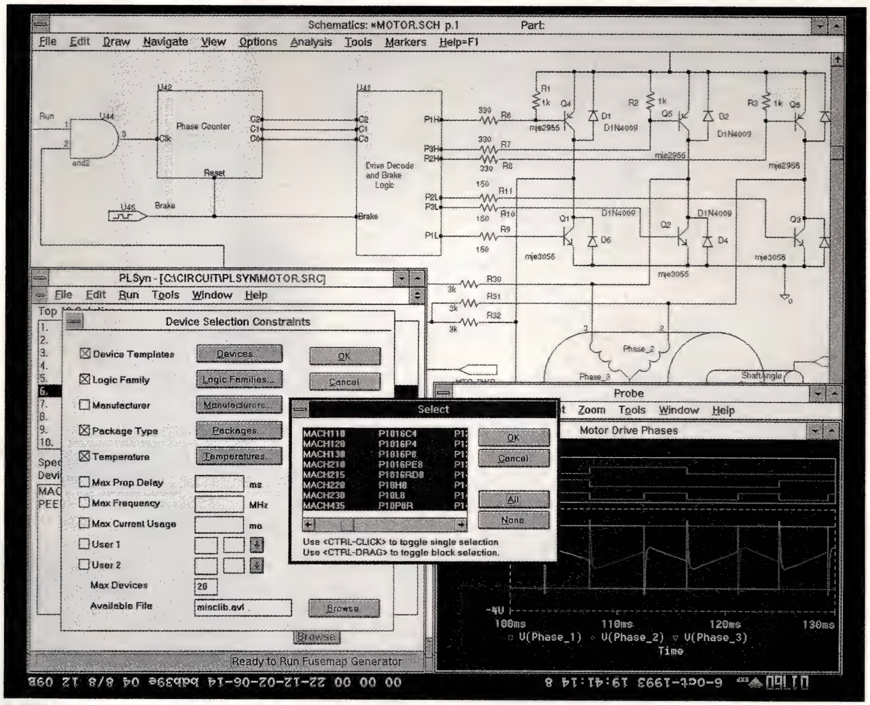
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Phase Counter
Drive Decode and Brake Logic
PLSyn - [C:\CIRCUIT\PLSYN\MOTOR.SRC]
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MACH120 P1016P4
MACH130 P1016P8
MACH210 P1016PE8
MACH215 P1016RD8
MACH220 P10H8
MACH230 P10L8
MACH435 P10P8R

Use <CTRL-CLICK> to toggle single selection
Use <CTRL-DRAG> to toggle block selection.

3. USERS HAVE CONTROL over which devices are chosen by the PLSyn environment. The window in the lower left of the screen lets users specify device-selection constraints, such as logic families, package type, and temperature. Device templates can be selected from the small window in the middle of the screen. Simulation results are shown with the Probe waveform-analysis tool in the lower right window.

figurations out of all the possible configurations. Users can then choose the one that they like best. PLSyn will create the device programming (JEDEC) files, and a schematic page that shows the programmable-logic devices and their interconnections.

Even though the device-selection and design-partitioning process is automated, PLSyn provides engineers with the control to create a specific physical design. Engineers can specify the device footprints, pinouts, special optimization parameters for a particular signal, partial or complete partitioning, and many other details of the physical implementation. The physical information is kept separate from the behavioral design data (the schematic), so that details of the behavioral design can change without affecting the physical design, or vice versa.

Users can also assign priorities to such design characteristics as total part costs, total pin count, propagation delay, operating frequency, and power-supply current. Then, PLSyn finds the best physical design based on these priorities.

Finally, PLSyn's device libraries cover more than 4500 device types from 22 manufacturers. Tools included with PLSyn allow engineers to limit the devices that are used by the tool when looking for a possible physical design. This keeps PLSyn from wasting time searching for designs that will be rejected by the engineer because they include a part that the engineer can't use. Engineers can remove parts from the library, and can also update part prices. In addition, two user-definable fields are available for device-selection constraints or priorities. ☐

PRICE AND AVAILABILITY

The PLSyn software will ship in February, 1994. It runs under Microsoft Windows on PCs, and on Sun workstations. There are various price configurations. Pricing for the PC version starts at $3500. The Sun workstation version starts at $7600.

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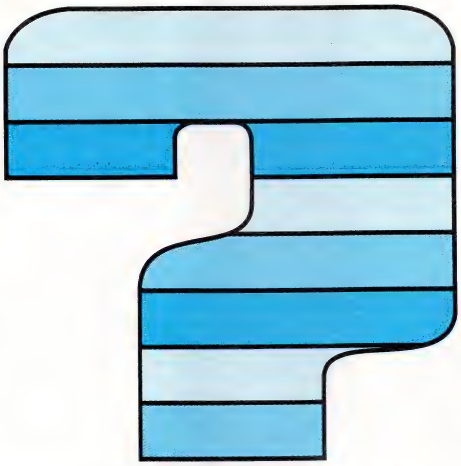

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1600 x 1280	200 MHz	64K (16-bit true color)	N/A

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TVP3020

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† Application based on a direct interface to VRAM with a maximum serial port speed of 50 MHz.

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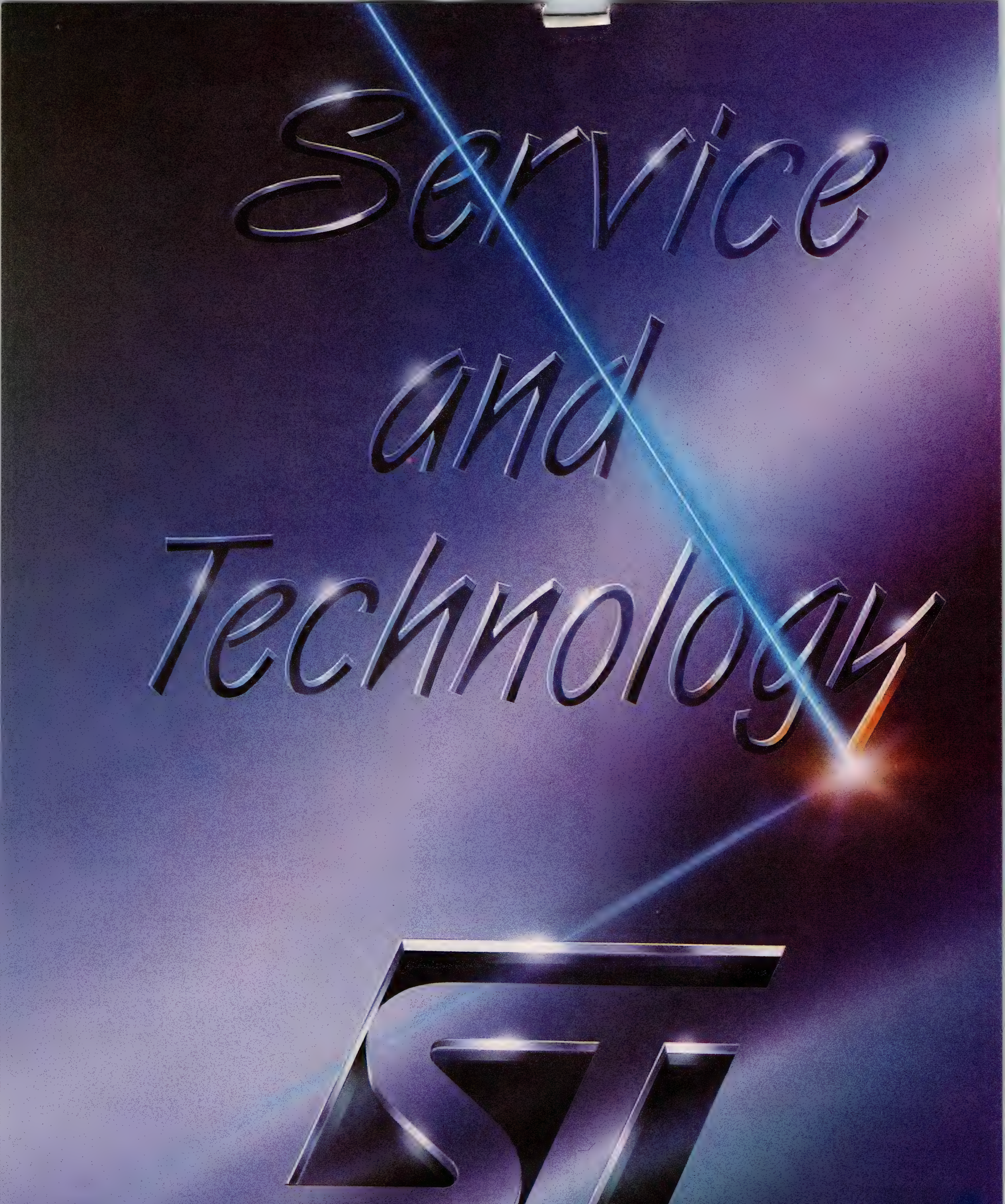

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TECHNOLOGY ROLLED UP IMPRESSIVE GAINS IN 1993

PACKAGING, DISPLAYS, AND STORAGE KEPT PACE WITH SYSTEM DESIGNERS' NEEDS.

JACK SHANDLE

The inexorable march of technology advances continued in 1993 just as it has in every year since the transistor was invented. In corporate, university, and national laboratories worldwide, techniques were being perfected that will make the industry's motto—"faster, smaller, cheaper"—as true one, two, three, or five years from now as it is today.

So as 1993 draws to a close, let's celebrate some of the more interesting technologies it unveiled. Of the developments chosen for this report, some were much heralded, while others weren't quite so glamorous but just as important. Needless to say, all were reported in *Electronic Design.*

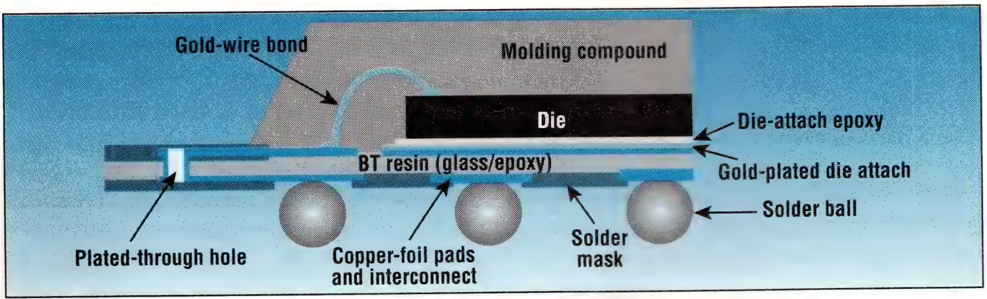
PACKAGING

Progress in all aspects of multichip-module (MCM) technology highlighted the year. The search for materials with thermal characteristics that lets MCMs handle the next high-powered generation of chips may have ended—for some applications—with the use of synthetic diamond as a substrate (ELECTRONIC DESIGN, *Apr. 15, p. 36).* Diamond's thermal conductivity is five times that of copper, and researchers at Sandia National Laboratories, Livermore, Calif., and Albuquerque, N.M., took full advantage of that characteristic in designing a power-electronics subsystem for a flight computer. Thermal models of the new MCM indicate it will operate within the performance requirement of not exceeding 150°C when the starting temperature is 110°C. The design concept calls for stacking alternate layers of 40 diamond substrates, each containing ICs and interconnects, and plastic spacer layers with conductive buttons that supply the vertical interconnect. The 100-cm cube will generate 369 W.

Still another family of substrates—sintered ceramics—may provide an answer to the nagging problem of reworking for MCM thin-film applications (ELECTRONIC DESIGN, *Apr. 15, p. 35).* Conventional silicon-dioxide substrates are so fragile that attempts at reworking the MCM—removing a defective chip, for example—generally ruin the MCM. The Via/Plane substrate technology developed by Micro Substrates Corp., Tempe, Ariz., solves this problem by making both sides of the substrate available for mounting chips.

The substrates of sintered alumina, aluminum nitride, or beryllia are tough enough to allow holes as small as 0.005 in. to be precision-drilled through them. The holes are filled with tungsten to create vias between the two sides of the substrate. The vias are sintered and the entire porous substrate is filled with copper. One side of the substrate can be used as the primary chip carrier. The other side, which is layered with thin-film circuitry, serves as the backup for replacing defective chips. Any rework can be connected through the vias. This is the first technology that allows thin-film MCMs to be successfully reworked.

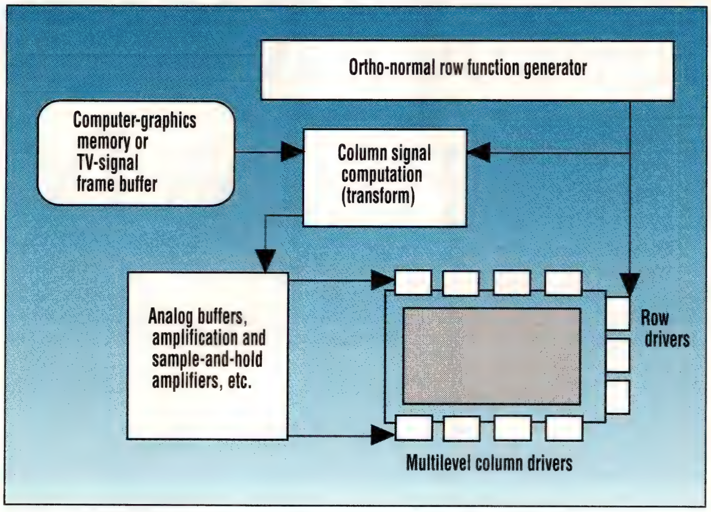
The economics of MCMs may see significant improvement if a technology developed by Z Systems Inc., Santa Clara, Calif., comes to fruition (ELECTRONIC DESIGN, *Mar. 18, p. 24).* The company used flat-panel-display manufacturing equipment to create the thin-film substrates on a 350-by-350-mm panel. The panel can hold 10 times more substrates than a 150-mm wafer, which means higher throughput and ultimately lower costs. The process can handle up to five metal layers, an interconnect



1. THE OVERMOLDED PAD-ARRAY CARRIER (OMPAC) uses solder balls instead of pins to connect chips to boards. The package includes a thin pc board and wire-bond pads that extend through plated holes on the board's periphery. Underneath, copper traces are routed from the holes to termination sites in a matrix of solder balls.

density of 400 lines per centimeter, and speeds up to 5 GHz.

Not all of the action in packaging was in MCMs. The use of solder balls to attach chips to pc boards also made news (ELECTRONIC DESIGN, *Feb. 4, p. 31).* The technology could ultimately displace plastic quad-flat-pack (QFP) technology in high-head-count ICs. With the overmolded pad-array carrier, (OMPAC) developed by Motorola Corp.'s Land Mobile Products Sector, Plantation, Fla., manufacturing engineers need not worry as much about lead skew and coplanarity. OMPAC packages can be placed on-board with an alignment tolerance of 12 mils, compared to 3 mils for QFPs.


Ortho-normal row function generator
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Multilevel column drivers

2. ACTIVE ADDRESSING of passive-matrix displays will bring passive-matrix technology in line with AMLCDs on screen performance while keeping prices low. This technology, developed by Motif Inc., uses complex algorithms to keep track of the rms voltage at each pixel.

During infrared reflow soldering, the solder balls tend to position themselves in the proper position, which eliminates the need for high-precision pick-and-place equipment. The package consists of a thin, BT-epoxy-laminate pc board clad with copper *(Fig. 1).* The top-side metallization carries a die flag and wire-bond pads. The wire-bond pads extend through plated holes on the board's periphery. On the back side of the board, the signal path is completed by copper traces routed from the holes to the termination sites in a matrix of solder balls.

In another 1993 development, power-device packaging got a lift from a technology developed by Gentron Corp., Scottsdale, Ariz., which delivers more power than wire-bonded hybrids and offers a hermetically-sealed package (ELECTRONIC DESIGN, *July 22, p. 35).* Inside the package, the device rests on a ceramic substrate fused to a copper shell. The massive contact between the semiconductor and its package results in lower series resistance and inductance.

The package design, known as Advanced Semiconductor Package, or ASP, also provides uniform heat dissipation and allows the device to be mounted on its edge instead of lying flat. ASP will be used first for MOSFETs and insulated-gate, bipolar transistors (IGBTs), says Gentron, but could be used for large signal-processing chips that dissipate high power levels.

DISPLAYS

Fueled by an enormous interest in smaller computers, personal digital assistants (PDAs), and personal communicators, flat-panel-display technology turned in some impressive achievements in 1993.

One of the most interesting developments was the utilization of single-crystal silicon and IC manufacturing equipment to produce flat-panel active-matrix LCDs with exceptionally high pixel densities. Kopin Corp., Taunton, Mass., conducted technology demonstrations that achieved resolutions of 500 lines/in. with a 1-lb. monochrome portable system operating at video-rate speeds. By using single-crystal silicon, the transistors that switch the liquid-crystals can be drawn with much finer lines (ELECTRONIC DESIGN, *Apr. 15, p. 59).*

Traditional active-matrix LCD (AMLCD) processes based on amorphous silicon, on the other hand, are limited to much coarser feature sizes. As a result, 150-line/in. resolutions are considered to be their practical upper limit. The core of Kopin's Smart-Slide technology is its ability to move the transistors on a thin film from the silicon onto the glass substrate that supports the display. Although the process is proprietary, Kopin claims there's enough headroom to extend the technology to 1000 lines/in.

While Kopin focused its efforts on increasing AMLCD-technology densities, Motif Inc., Tualatin, Ore., announced a technology that pushes passive-matrix LCD displays closer in performance to AMLCDs (ELECTRONIC DESIGN, *Apr. 15, p. 59).* In a joint venture with In Focus Systems Inc., Tualatin, and Motorola Semiconductor Corp., Phoenix, Ariz., Motif found a way to actively address passive-matrix displays. Passive-matrix displays have conventionally been addressed by selecting the rows and columns with a single 20-V pulse once each frame. This technique isn't very effective, however, for computer displays that need fast crystals to show movement of cursors or graphics. The result in passive-matrix displays was loss of contrast and flicker, in addition to a swimming effect.

Motif's solution is based on the fact that the switching mechanism of liquid crystals depends on an rms value of voltage. But the rms voltage need not be implemented with a single pulse. Motif's active-addressing scheme provides a continuous voltage on each pixel, giving the pixel just enough added electrical energy when it's to be switched on. All rows are selected at once with special, low-amplitude, bilevel signals. Complex algorithms have been developed using digital-signal-processing (DSP) techniques to implement this complex addressing scheme *(Fig. 2).* Close to active-matrix performance characteristics can be achieved, and in some instances surpassed, with Motif's passive-matrix displays. These include 30-ms response time, a contrast ratio of 30:1, 64 gray levels, and a palette of 262,144 colors—all at a cost of about one-half of TFT displays, according to Motif.

Sharp Electronics, Camas, Wash., also used a novel

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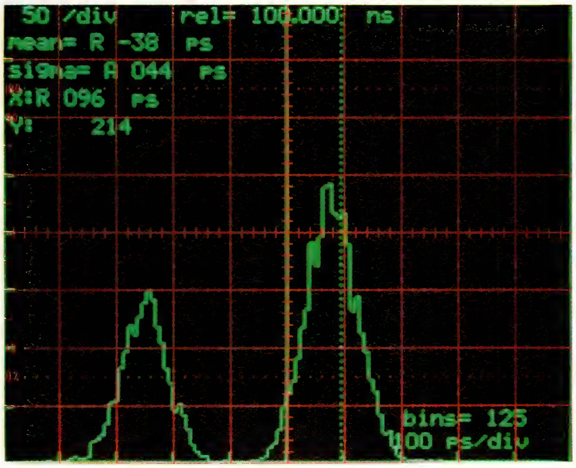
SR620 Output



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HP5370B Output

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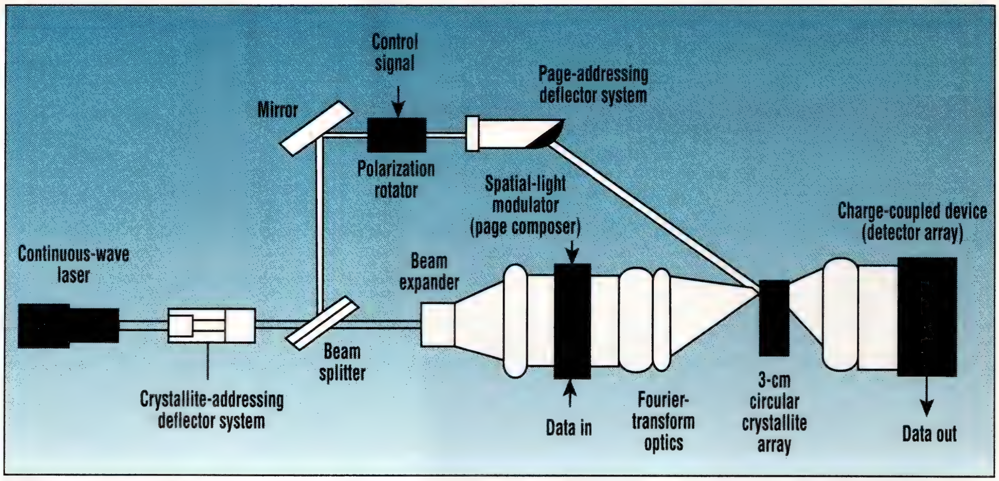
addressing scheme to boost electroluminescent displays. Split-screen addressing doubles the refresh rate from 60 to 120 Hz while at the same time reducing power consumption by 30%. Sharp's engineers split the row electrodes into two distinct banks, one covering the upper part of the screen and the other covering the lower part (ELECTRONIC DESIGN, *July 22, p. 38).* Both groups are driven simultaneously at 60 Hz. In terms of pixel refreshes per second, this is equivalent to driving the entire screen at 120 Hz. By doubling the number of times each pixel's phosphors are refreshed, the panel's light output stays closer to its peak. One residual benefit of higher light output is the ability to create eight gray-scale levels by modulating the refresh signals.


Control signal
Page-addressing deflector system
Mirror
Polarization rotator
Spatial-light modulator (page composer)
Charge-coupled device (detector array)
Continuous-wave laser
Beam expander
Beam splitter
Crystallite-addressing deflector system
Data in
Fourier-transform optics
3-cm circular crystallite array
Data out

3. VOLUME HOLOGRAMS are generated using a 100-mW, green-light, yttrium-aluminum-garnet (YAG) laser that emits radiation at 532-nm coherence length. The laser beam is split into a reference beam and a data beam. The data beam passes through a page composer and then to a crystalline array, where it forms an electric charge pattern when it interferes with the reference beam.

The coming age of high-definition TV may find the high-contrast, high-resolution display it needs for projection TV in a technology pioneered by Texas Instruments Inc., Dallas. The imaging technology uses aluminum micromirrors fabricated on silicon to create 24-bit color images with 768-by-576-pixel resolution (ELECTRONIC DESIGN, *June 10, p. 23).* The chip begins as a random-access memory that stores charge on the device's surface. Next, a 2-μm-thick layer of photoresist polymer is laid down on top of the DRAM cells and a grid of 17 μm^2 is etched in the polymer. Aluminum is sputtered over them to create the mirrors. Another etch creates the individual mirrors, posts, and torsion hinges. The last step is a plasma etch that removes all of the polymer under the grid. Light from an arc lamp illuminates the array of mirrors and a color wheel produces the color, with the mirrors being tilted three times for each frame being displayed. Because the frame lasts only 16.5 ms, the eye integrates the RGB reflections into one image.

Not all of the advances were in conventional 2D displays. The usability of 3D displays got a boost in 1993 when LCD technology was combined with a novel illumination plate. Dimension Technologies Inc., Rochester, N.Y., developed the technology (ELECTRONIC DESIGN, *July 8, p. 36).* It starts by displaying the left-eye and right-eye images on alternate columns of the LCD screen. The illumination plate behind the LCD, which provides the light for the display, uses lenslets to create very thin, very bright vertical lines of light. Only the light that passes through the odd columns reaches the left eye. For the right eye, the light passes through the even columns. The system's main drawback is that it produces one-half the LCD-panel's resolution. Dimension Technologies solved that problem by doubling the frame rate. It uses an advanced custom TFT for the switching to support that frame rate.

STORAGE

One of the clearest signals from the labs in 1993 is that magnetic storage still has lots of life left. Even as magnetoresistive read/write heads begin to make their way into commercial disk drives, researchers at IBM Corp.'s Laboratories in Almaden, Calif., revealed progress in harnessing a phenomenon known as giant magnetoresistance (ELECTRONIC DESIGN, *Sept. 16, p. 46).* The term giant is used because at a field strength of 12 oersteds, a resistive change of about 6% can be achieved in the head's 20-Å-thick nickel-iron (NiFe) layer. The percentage change is three times greater than a standard Permalloy head. The larger resistance translates into a five-fold improvement in the signal amplitude the head can deliver to the read-channel circuits. This, in turn, can provide a five-fold increase in storage density. Disk drives that use giant MR heads could pack as much as 10 Gbits/in.^{2} by the end of the decade, claim the researchers.

The physics behind the technology involves a process that separates the NiFe substrate into small regions. This is done by interposing a 40-Å layer of silver between the NiFe layers and annealing the substrate to 300°C.

Less advanced but still impressive results from using new materials were announced by Sony Corp. of America, Park Ridge, N.J. Instead of the read head, Sony's materials technology focuses on the media itself (ELECTRONIC DESIGN, *July 22, p. 27).* By adapting a metal alloy used for 8-mm video and metallic digital audio tapes, Sony's researchers were able to store 21 Mbytes on a 3.5-in. floppy disk.

But the metallurgy alone wasn't enough. Sector servo tracking, zone management, and 2-7 run-length-limited (RLL) coding also contribute to the increased storage capacity. To read data, the magnetic head traces a servo signal encoded on the disk during the manufacturing process. The RLL encoding increases the data's linear density, and zone management helps by utilizing more of

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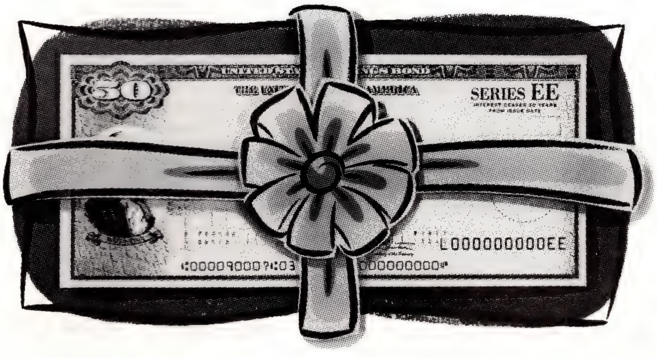


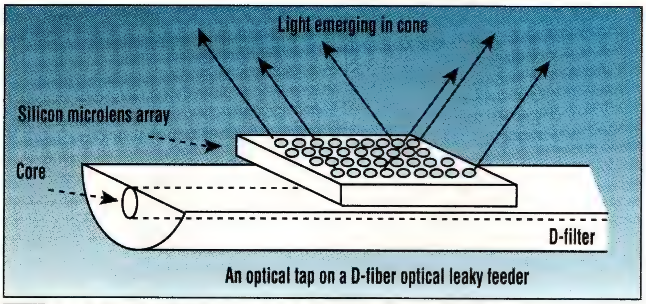
the disk's outer portion. The disks will be read- and write-compatible with conventional drives.

Other expected floppy-disk-drive advances stress lower manufacturing cost and improved ruggedness. Look for glass-ceramic materials to replace aluminum as a substrate material in the near future thanks to a joint project between Corning Inc., Corning, N.Y., and Seagate Technology Inc., Scotts Valley, Calif. (ELECTRONIC DESIGN, *May 13, p. 32)*. The result, a glass-ceramic called MemCor, has a number of advantages over aluminum. It lets the read/write head fly as close as 2 μin. above the disk's surface, allowing higher areal densities. MemCor's real advantage, however, is its strength: It can withstand shocks of up to 100 Gs higher than aluminum. The material's strength will allow the omission of a layer of nickel now used in aluminum-based disks to increase their strength. And, being a glass-ceramic material, MemCor is immune to the magnetic defects caused by the inter-metallics found in aluminum.

To go along with the improvements in density, researchers also have been busy perfecting technologies that will transfer the information off the disk at much higher rates. An acoustic-charge-transport (ACT) technology developed by Comlinear Corp., Fort Collins, Colo., holds the promise of supporting 100-Mbyte/s, hard-disk, read-channel data rates (ELECTRONIC DESIGN, *Apr. 1, p. 25)*. Fabricated in gallium arsenide (GaAs), the ACT technology was demonstrated at 60 Mbytes/s while using standard peak detection and thin-film heads. Bit densities on the disk can be 50% higher than most high-end drives, and bit-error rates are on the order of 10^{-9}. The demonstration was implemented on one MCM in a 100-pin QFP.

All of the advances in magnetic storage may, however, be overshadowed (in high-end applications at least) by volume-holographic storage. After years in research, this exotic technology seems to be finally on the verge of commercialization. Among its attributes are storage densities 10 times greater than conventional magnetic or optical recording, and data-access speeds and transfer rates between 10 and 1000 times faster than conventional systems (ELECTRONIC DESIGN, *Sept. 16, p. 93)*.

In this technology, data is recorded as dark or light "dots" inside photorefractive crystals. These patterns create two-dimensional holograms called pages. The pages are stacked one on top of the other within the crystal. Strontium-barium-niobate crystals are used because they combine high sensitivity with high speed.



4. AN OPTICALLY-BASED SOLUTION to microcell communications begins with a purposefully leaky fiber-optic cable. The cable's cross section looks more like a capital D with the lightwave-carrying core being just a few micrometers below the flat surface of the cable. Lenslets at the optical taps focus the radiated energy in broad or narrow bands.

Electronic-charge patterns created by laser interference are used to produce the holograms *(Fig. 3)*. In the most basic system, light from a laser source passes through a beam splitter that divides the beam into a data beam and a reference beam. The reference beam will eventually be used to create the interference pattern. It's directed into a path that includes a polarization rotor and a page-addressing deflection system. The data beam, on the other hand, passes into an optical system that expands it onto the surface of a device known as a page composer, which is implemented as a spatial-light modulator. Digital data is superimposed on the expanded beam using the spatial-light modulator. The images appear as dark or light spots, depending on the value of the digital data.

From the page composer, the data beam is converted using Fourier-transform optics. Then it's focused on the crystalline structure that will hold the hologram. At this point, the data and reference beams fuse together again and the resulting interference produces a unique grating pattern on a photorefractive material. This, in turn, modifies the optical properties of the crystalline material with an electronic-charge pattern.

Developed at the Microelectronics and Computer Technology Corp., Austin, Texas (MCC), this just-described volume-holographic technology is capable of an average page-access time of 1 μs. Prototypes have used page sizes of 64 kbits with up to 50 pages per stack and up to 2000 stacks of pages per module. Employing 3-by-3-by-0.5-cm crystals yields a capacity of 200 Mbytes. Write times are in the range of 100 μs and average sustained transfer rates are estimated as high as 800 Mbytes/s.

COMMUNICATIONS

Strange as it may seem, holograms are playing a role in a research project aimed at using infrared radiation for cellular and personal-communications-services (PCS) networks. Researchers at the Marlesham Heath, U.K., laboratories of British Telecom plc use holograms as a safety measure to avoid overexposure to radiation from the wide-area network. The network's media is itself novel: a leaky fiber-optic cable that uses lenslets at the optical taps to focus the radiated energy in broad or narrow bands according to the environment. At each tap, power is refracted through 90° so that it radiates from the fiber. Each tap can feed a transmitter that communicates with handheld or stationary terminals (ELECTRONIC DESIGN, *Sept. 16, p. 34)*.

Instead of being a perfect cylinder, the cable's cross section looks more like a capital D, with the lightwave-carrying core being just a few micrometers below the flat surface of the cable *(Fig. 4)*. No optical power is lost as long as the material in contact with the flat surface has a lower index of refraction than the fiber's core.

Taps are created by placing a material with a higher refraction index on the flat part of the cable. Lenslets shape the beam over a narrow or wide range. Safety is a

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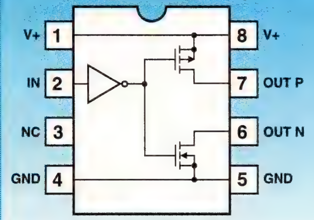

Non-Inverting
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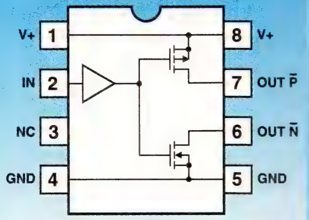
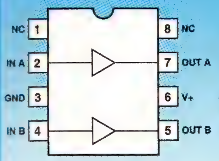


Inverting
- Isolated Drains
- 20 ns Switching Time
- $1.96 – 100's P-DIP

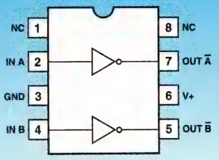
Dual Channel, 2.0 Amps Output

EL7202



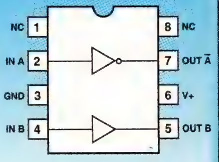
Non-Inverting
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.96 – 100's P-DIP

EL7212



Inverting
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.96 – 100's P-DIP

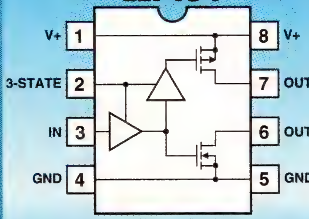
EL7222



Complementary
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.96 – 100's P-DIP

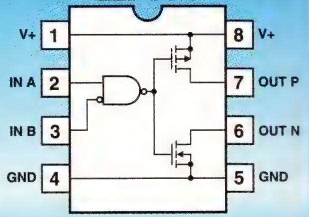
3-State Line Driver/Dual Input Line Driver, 4.0 Amps Output

EL7134



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.40 – 100's P-DIP

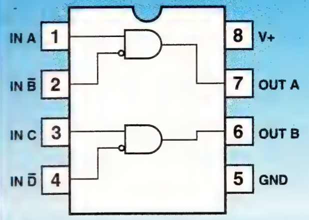
EL7144



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.40 – 100's P-DIP

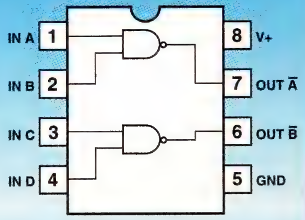
Dual Channel/Dual Input, 2.0 Amps

EL7242



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

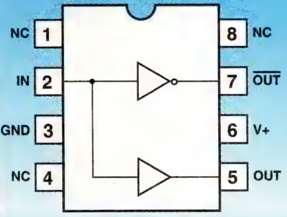
EL7252



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

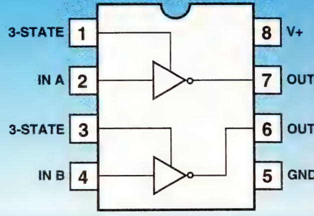
CCD Driver/Dual Channel 3-State Line Driver

EL7182



- Reduced Clock Skew
- 20 ns Switching Time
- $2.65 – 100's P-DIP

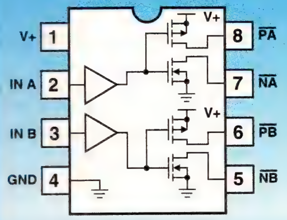
EL7232



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

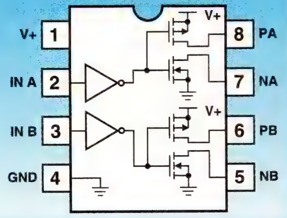
Dual Channel – Isolated Drains, 2.0 Amps

EL7262



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

EL7272



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

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concern, however, since laser diodes have outputs of up to 100 mW, opening the possibility for the fiber to break. That's where the holograms come in.

The researchers convert the single-point light into many beams of equal intensity by using computer-generated holograms. By changing the hologram's pattern, engineers can tailor the light distribution to specific needs. Although the technology is still in its formative stages, project leader Peter Smyth estimates that for a typical office with a 10-by-10-m floor, the system could provide data rates between 10 and 100 Mbits/s.

Optical communications, such as the technology being developed by British Telecom, may in the long run benefit from semiconductor research that was reported by Sandia National Laboratories, Albuquerque, N.M., in 1993. Researchers there found a way to fabricate low-voltage reflectance modulators using tiny compound-semiconductor mirrors (ELECTRONIC DESIGN, *Jan. 7, p. 39).* The mirrors can be used to convert information carried by electrical energy into lightwave information.

The technology owes its low-voltage attribute to the fact that light energy is magnified by the back-and-forth reflections of light in a Fabry-Perot cavity between the mirrors. The most obvious applications for reflectance modulators are in optical connects in communications equipment and computers.

Reflectance modulators are made by combining strained-layer superlattices with strain-relieved buffer layers and mirror compositions. Sandia's device was fabricated using multiple alternating thin layers of indium-gallium-arsenide (InGaAs) and indium-aluminum-gallium-arsenide (InAlGaAs) to create quantum-well resonators. Thicker layers of the materials form the mirrors. The result is a round device that's a few millimeters in diameter and 100-μm thick.

Electrically, the device is a p-i-n diode with the mirrors being the p- and n-type terminals across which the amplitude-modulated voltage is applied. Sandia succeeded in fabricating a reflectance modulator that operates at a wavelength of 1.3 μm, thus producing less dispersion in optical fibers than shorter-wavelength devices and presenting less danger to the eye.

Although lightwave communications played an important role in communications research in 1993, there were developments in other areas as well. One more conventional technology that might be employed with future incarnations of PCS was first developed for military applications, but was repositioned in 1993 for commercial uses. Impulse radio conveys information by slightly changing the timing of very short pulses instead of using amplitude or frequency modulation (ELECTRONIC DESIGN, *Feb. 4, p. 32).*

In pulse-position modulation, the pulse train is typically generated at intervals between 0.5 and 1.5 ns. A 1-ns pulse has a center frequency of 1 GHz and a 0.6-ns pulse has a 2-GHz center frequency. The pulse train is modulated by slight differences (called dithers) in the time that the pulse would usually be expected. Because the pulse is so short, a considerable amount of information can be transferred, right up to video data rates.

Pulson Communications Inc., McLean, Va., adapted the technology to PCS requirements and estimates a consumer product could be produced for under $200. Power consumption is relatively low, and the talk time provided by four AA batteries could be up to 16 hours. The company and its technology will have to wait a while, however, since the U. S. Federal Communications Commission has focused on more traditional cellular technologies in its most recent decisions.

SENSORS

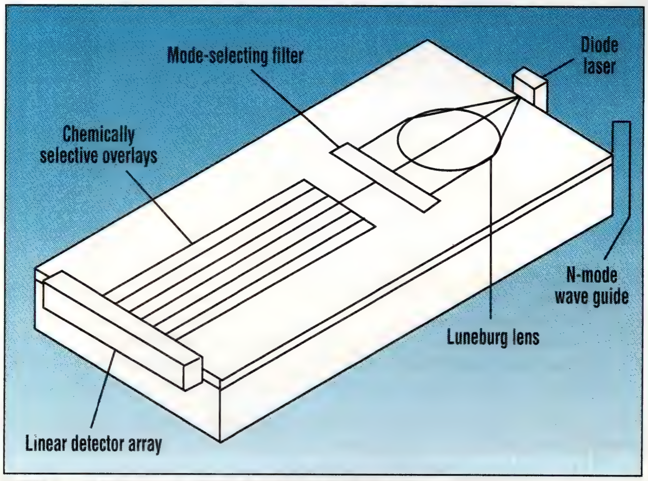
Sensing technology made strides in 1993, particularly at the semiconductor level. Using a standard CMOS process, a Scottish company came up with a light sensor that rivals charge-coupled devices (CCDs) in performance and can be integrated with chip logic, making it a smart sensor (ELECTRONIC DESIGN, *June 10, p. 29).*

VLSI Vision Ltd., Edinburgh, Scotland, creates photodiodes by extending and exposing the source region of a standard MOS transistor. Each photodiode becomes a pixel in the imager. The prototype device uses a 256-by-256-pixel array. All of the gates in each row are driven by a common source.

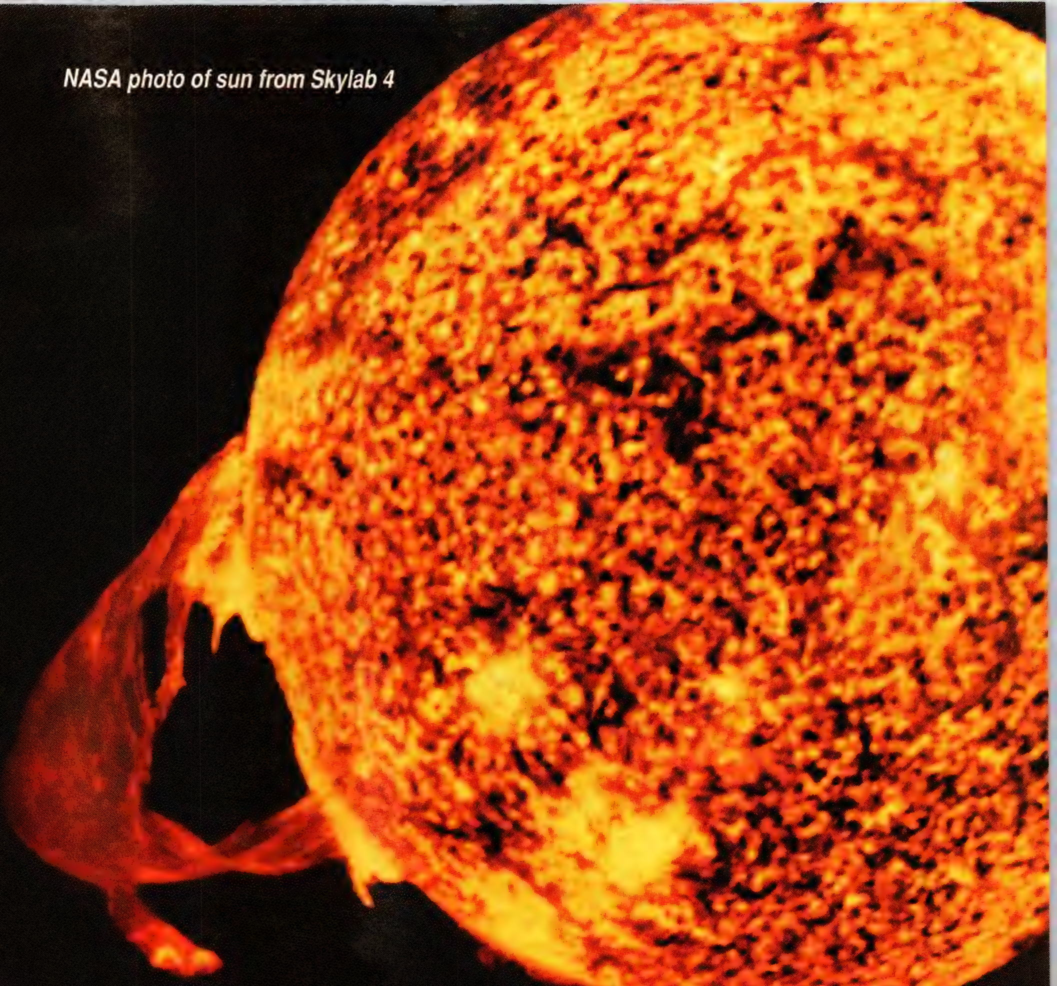
Reverse-biased photodiodes convert incident light to small currents that gradually discharge the gate capacitances. Each photodiode is read by connecting the photodiode to the MOS transistor gate by opening the gate. All of the transistor drains in the array are connected to a common ground.

Although this scheme has been implemented before, it didn't achieve CCD-level performance. VLSI Vision's contribution was to use a separate charge-sense amplifier for each column. The sense-amplifier output is first sampled, and then this information is multiplexed though an on-chip integrator. By using an analog multiplexer to switch in blanking and synchronization levels, the chip delivers a 1-V peak-to-peak video waveform.

Research laboratories are employing optical sensing



5. RESEARCH IS UNDERWAY at university and corporate laboratories to harness light as a primary sensing medium. Interferometers are being investigated at Georgia Tech, for example, as environmental sensors. When chemically selective overlays absorb a specific chemical, the refraction index of the overlay changes and light is defracted onto a detector array in a different pattern from the reference.



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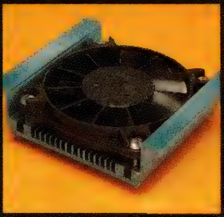

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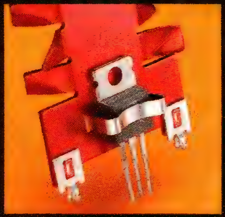

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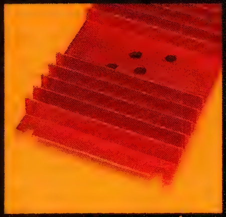

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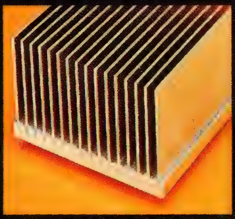

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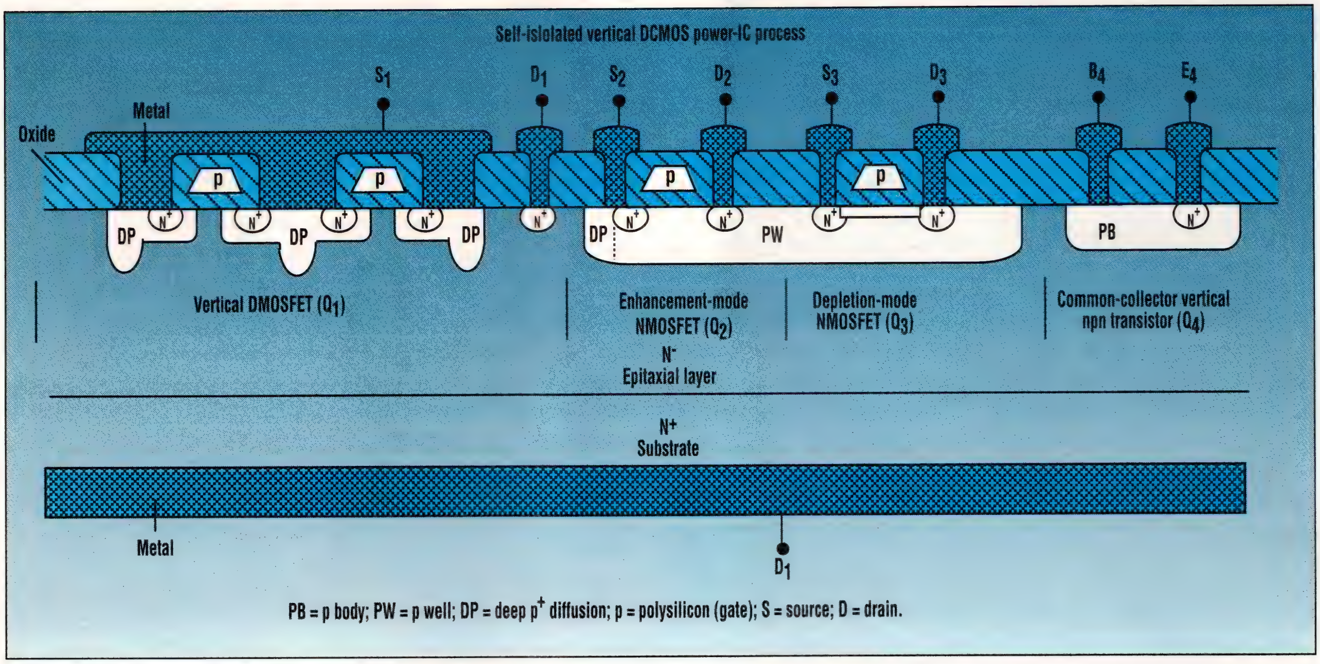
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Common-collector vertical npn transistor (Q4)
N-
Epitaxial layer
N+
Substrate
Metal
D1
PB = p body; PW = p well; DP = deep p+ diffusion; p = polysilicon (gate); S = source; D = drain.

6. A FABRICATION TECHNOLOGY for power MOSFETs integrates intelligence on the die by adding three types of small-signal transistors that require only four additional mask steps. The small-signal devices are an enhancement mode n-channel MOSFET, a depletion-mode n-channel MOSFET, and a common-collector vertical npn transistor.

in many different applications. Pollution sensing is one target because optics can potentially detect much lower concentrations than electronics-based sensors. Engineers at the Georgia Institute of Technology, for example, developed a generic device called an integrated-optic interferometer (ELECTRONIC DESIGN, *June 24, 1993, p. 55).* This planar waveguide consists of a glass substrate that's about an inch square. It's coated with a thin film with a higher index of refraction than glass *(Fig. 5).*

The thin film is made of a material that reacts in a detectable but reversible way with the contaminant the device is supposed to sense. The basic operating model calls for the refraction index of the thin film to vary proportionally with the amount of contaminant it absorbs.

Changes in refraction are measured by splitting a beam of laser light into two beams. One propagates through the glass-based substrate to establish a reference point. The other beam propagates through both the substrate and the thin film. If the film's refraction index changes, the beam will undergo a phase shift that's proportional to the concentration of the contaminant. Calibration curves were developed to measure the amount of contaminant down to parts per billion.

Because the device is small and its operation is relatively simple, it can easily be used at the contamination site. Or a single sensor can be employed to detect more than one contaminant because several different types of thin films coat the glass substrate.

Light is also being experimented with as a means of measuring biological parameters. For example, a joint project between the University of New Mexico, Albuquerque, N.M., and Sandia Laboratories aims at non-invasive blood-glucose monitoring. Because near-infrared light can penetrate biological tissue, and the fact that the chemical components of blood selectively absorb specific wavelengths of light, led to the prototype monitor. Statistically analyzing the spectral characteristics of the remaining light can gauge glucose levels. One of the applications envisioned for the sensor is to team it up with a microcontroller and a programmable glucose pump to create what amounts to an artificial pancreas.

The past year also saw Fujitsu Ltd. looking into glucose sensing at its Japan laboratories, but using quite a different device. Fujitsu's researchers micromachined a miniature Clarke oxygen electrode in silicon. The sensor detects changes in oxygen concentration caused by a glucose oxidase enzyme located in the sensor. The amount of oxygen generated is almost linearly proportional to the current generated by the Clarke oxygen electrode.

The initial design built the electrode on a 2-by-15-by-400-mm undoped silicon substrate. The electrolyte is contained in two etched 0.1-by-0.7-mm grooves. Both the anode and cathode are formed by 400-nm-thick gold film with a 40-nm chromium adhesive layer. The anode is produced in the grooves and the cathode between the grooves. Several compounds are being evaluated as electrolytes. In addition to glucose, the sensor can be adapted to detect levels of carbon dioxide, L-lysine, and hypoxanthine, a chemical linked to the freshness of fish.

PROCESS TECHNOLOGY

The driving force behind the electronics industry is semiconductors and the process technologies that make them possible to keep packing more functions on faster and faster chips year after year. The industry witnessed many innovations in this area during 1993.

Spread-spectrum communications systems and other wireless products might get a lift from a GaAs process

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developed at TRW's Space and Electronic Group, Redondo Beach, Calif. The first commercial product is a linear-amplifier IC capable of operating at up to 1 GHz with high efficiency (ELECTRONIC DESIGN, *May 3, p. 28).*

TRW fabricates heterojunction-bipolar transistors (HBTs) using a proprietary molecular-beam-epitaxy (MBE) process. MBE provides consistent doping profiles that deliver high-yield, reliable amplifiers with efficiencies approaching 50%. That's considerably more efficient than existing monolithic or hybrid GaAs amplifiers that operate in the same regions. The first family of devices consume about 800 mW and run of a 6-V rail. Future devices will consume from 100 mW to 2 W.

The high end of the semiconductor speed scale has been occupied in recent years by superconducting materials. In March, a 32-bit shift register fabricated with a high-temperature superconductive process was clocked at 120 GHz (ELECTRONIC DESIGN, *Mar. 18, p. 23).* The device, which integrates 64 Josephson-junction nanobridge active devices in a single-flux logic architecture, is the most complex digital circuit ever operated using high-temperature superconducting materials, claim researchers at Conductus Inc., Sunnyvale, Calif. The researchers fabricated the shift register using yttriun-barium-copper-oxide (YBCO), which begins to exhibit superconducting properties at –196°C. Most high-temperature superconductors require –296°C to operate.

On a more down-to-earth topic, power semiconductors added a few process enhancements to their bag of tricks in 1993. International Rectifier, El Segundo, Calif., managed to do what was once considered unlikely—make a smart power MOSFET by adding only four mask steps. The result is a MOSFET with extensive self-protection features, which include characteristics such as thermal protection and overcurrent sensing.

The process features four types of transistors: a vertical DMOSFET and three small-signal devices *(Fig. 6).* The small-signal devices are an enhancement-mode n-channel MOSFET, a depletion-mode n-channel MOSFET, and a common-collector vertical npn transistor. Substituting the depletion-mode FET for a p-channel FET is the key to the process' simplicity. It and the enhancement-mode FET are used for analog circuits as well as for logic. The npn transistor can be utilized for circuits like high-voltage clamps and bandgap references. The four additional process steps involve p-well diffusion, the depletion-area mask and its implantation, the p-body mask, and the n^+ mask and etch step.☐

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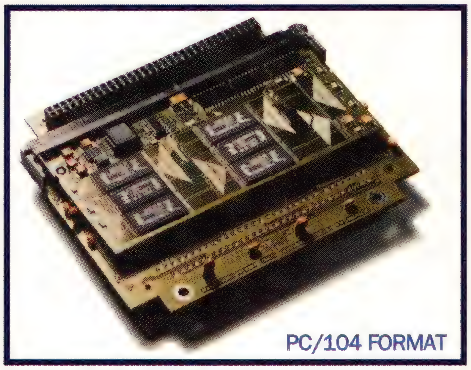

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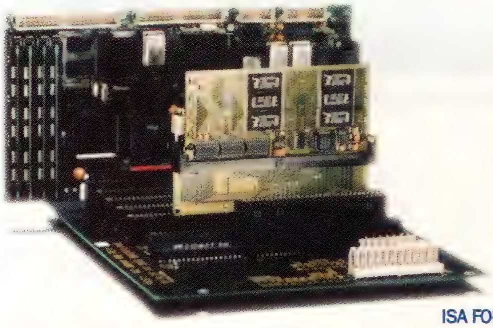

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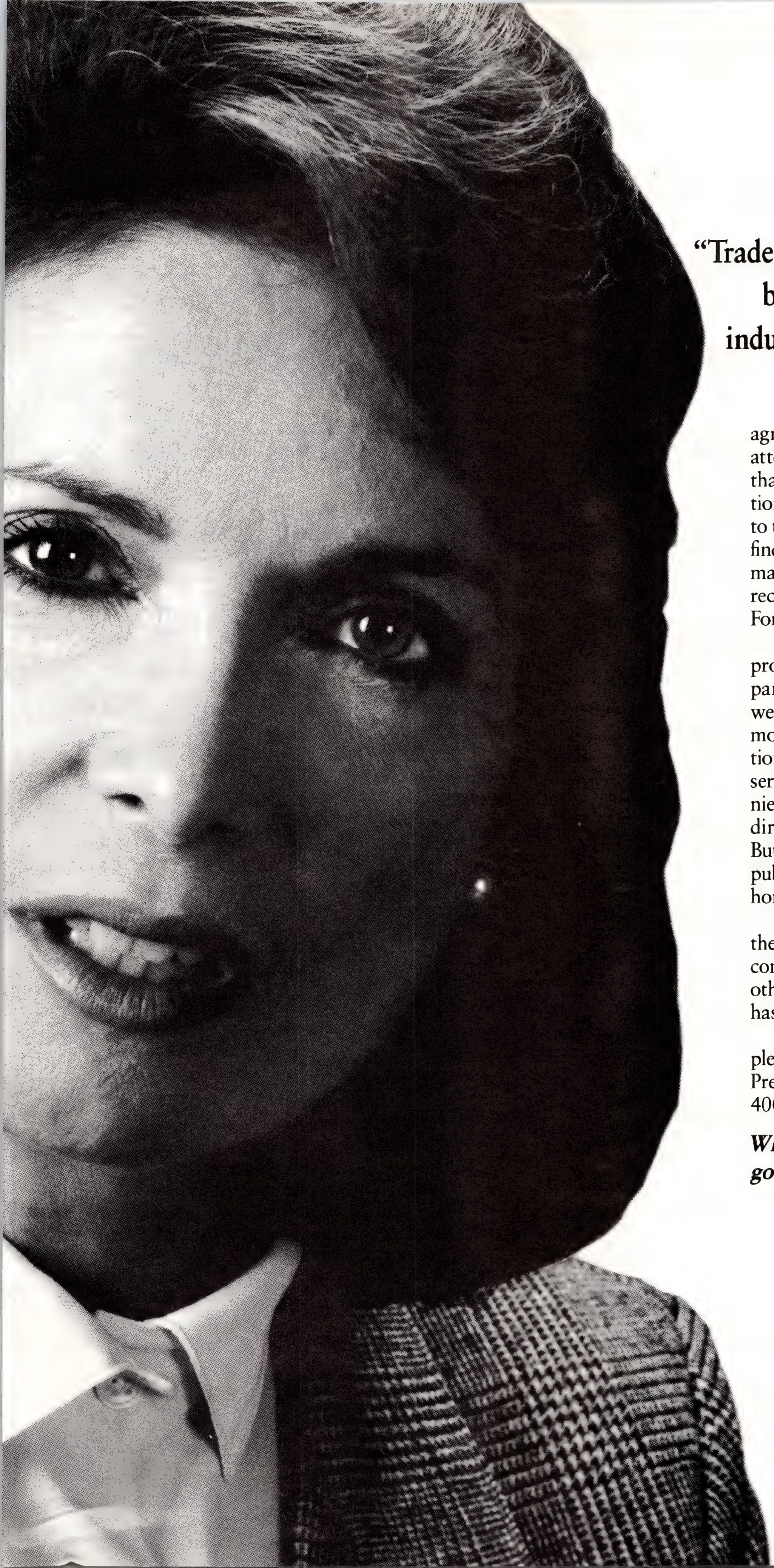

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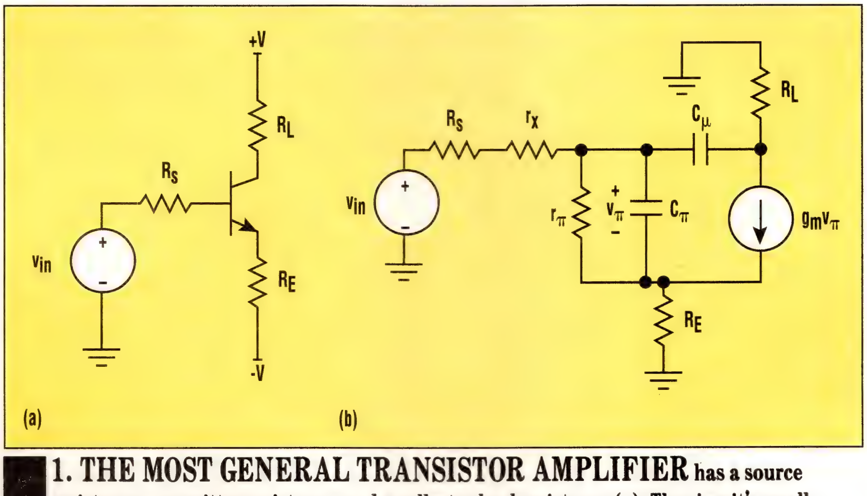
USEFUL APPROXIMATIONS AND TECHNIQUES HELP ENGINEERS USE OPEN CIRCUIT TIME CONSTANTS TO EXPLORE A CIRCUIT'S BANDWIDTH.

NETWORK TRICKS AID IN OCTC CIRCUIT ANALYSIS

The main function of the open circuit time constants (OCTC) analysis method is to estimate the high-frequency –3-dB point of an amplifier. A previous article (ELECTRONIC DESIGN SPECIAL ANALOG ISSUE, *June 24, p. 41)* introduced the technique, and illustrated that the major benefit of OCTC analysis was the information it provided on the circuit element most affecting the bandwidth. This article discusses the nitty-gritty of how to calculate the time constants for a transistor amplifier, and suggests circuit-analysis techniques and approximations.

First, it's useful to go through the derivation of the open-circuit resistances of the most general transistor amplifier *(Fig. 1a)*. This transistor amplifier has a source resistance (R_s), an emitter resistance (R_E), and a collector load resistance (R_L). Of course, you can calculate open-circuit resistance by writing lots of node equations and grunging through pages and pages of math. But with a little thought and judicious application of intuitive models, the problem becomes almost reasonable. It's important to stop, take a deep breath, and interpret the physical significance of results as you go along.

You can determine the resistances using the circuit's small-signal model.



1. THE MOST GENERAL TRANSISTOR AMPLIFIER has a source resistance, an emitter resistance, and a collector load resistance (a). The circuit's small-signal model substitutes resistors and capacitors for the transistor (b).

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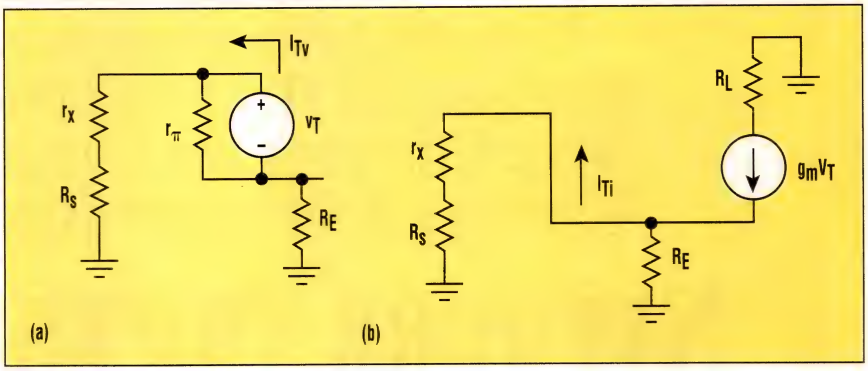
For the most difficult case, calculate R_{1o} (the resistance facing C_π with C_μ open-circuited), and R_{2o} (the resistance facing C_μ with C_π open-circuited).

To calculate R_{1o}, apply a test-voltage source (V_T) to the C_π circuit terminals, and compute the resulting current (I_T). The resistance R_{1o} is the ratio of voltage to current. The first trick to pull out of the engineering toolbox is the principle of superposition. Engineering school teaches you not to use superposition with dependent sources. But you can in this case, because the test-voltage source constrains v_π to be a constant V_T. Therefore, you can compute two components of the resulting current separately—one due to the voltage source V_T and the other due to the dependent current source g_mV_T. The total test current is the sum of these two currents. In other words, you're breaking a difficult problem into two easier pieces.

To determine the current I_{Tv} due to V_T only, disable the g_mV_T current source by open-circuiting it *(Fig. 2a)*. This results in:

$$I_{Tv} = \frac{V_T}{r_\pi} + \frac{V_T}{R_s + r_x + R_E} \tag{1}$$

To find the current I_{Ti} due to the dependent current source only, shut off the V_T voltage source by shorting it *(Fig. 2b)*. The resulting test current is found by calculating a current divider with the current-source value acting as if V_T were still active. This results in:



2. TO BEGIN CALCULATING the circuit's open circuit time constants, first find the resistance R_{1o} facing C_π, with C_μ open-circuited. R_{1o} is computed with the ratio of voltage to current. In this circuit, the current must be calculated in two components—one due to the voltage source V_T (a), and the other due to the dependent current source g_mV_T (b).

$$I_{Ti} = g_m V_T \frac{R_E}{R_s + r_x + R_E} \tag{2}$$

The total test current is the sum of the two components:

$$I_T = V_T\left[\frac{1}{r_\pi} + \frac{1 + g_mR_E}{R_s + r_x + R_E}\right] \tag{3}$$

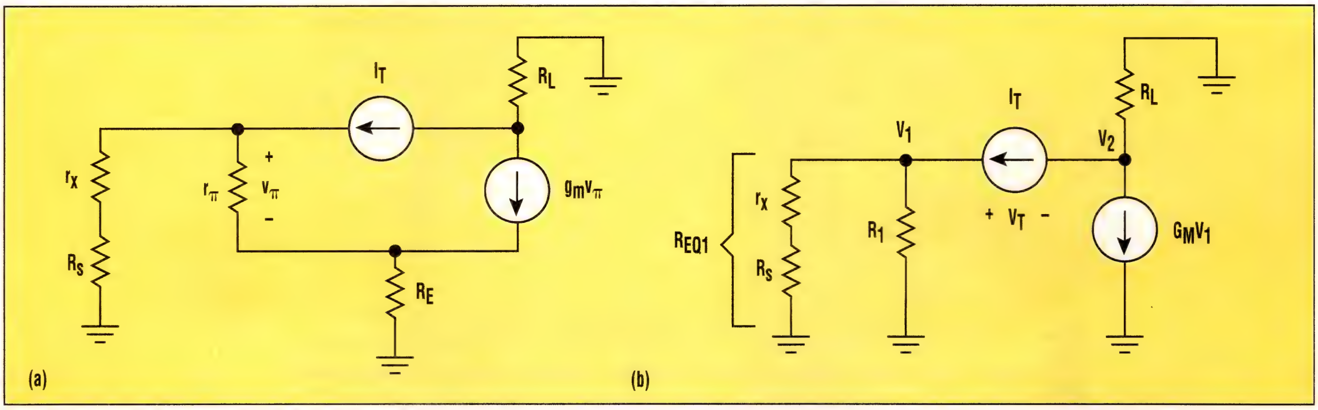
If you think about Equation 3 in reverse, it's clear that this equation form is for resistors in parallel. It follows, then, that the resistance facing C_π is:

$$R_{1o} = r_\pi \left\| \frac{R_s + r_x + R_E}{1 + g_mR_E} \right. \tag{4}$$

It makes sense that R_{1o} is equal to r_π in parallel with a bunch of other circuit elements, because r_π in the transistor circuit is measured directly across C_π. Also, the time constant decreases as R_E increases because less and less voltage will appear across C_π, decreasing the relative importance of C_π.

For R_{2o}, the circuit is a bit more difficult, but not impossible. The circuit has a test-current source shown across the C_μ terminals *(Fig. 3a)*. Now, if you blindly forge ahead and write node equations, you'll arrive at a horrendously complicated result that gives no insight into the circuit's operation. One time-honored technique in electrical engineering is to transform a difficult problem into a form that's easier to solve. Then, the results of the transformed circuit are applied to the original circuit.

Keeping this philosophy in mind, replace the equivalent resistance at node V_1 by a resistance R_1, which takes into account the input imped-



3. THE RESISTANCE FACING C_μ with C_π open-circuited is even more difficult to calculate. Applying a test current source across the C_μ terminals yields a complicated result (a). It's better to replace the equivalent resistance at node V_1 by a resistance (R_1) that accounts for the transistor's input impedance, and to substitute an equivalent dependent source (G_MV_1) for the g_mv_π generator.

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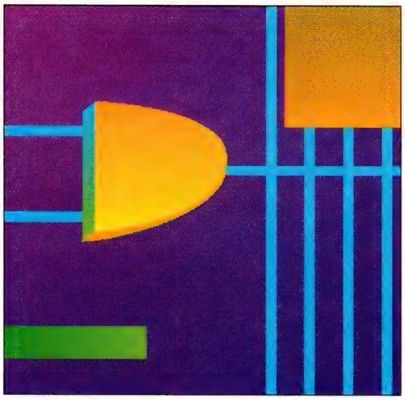

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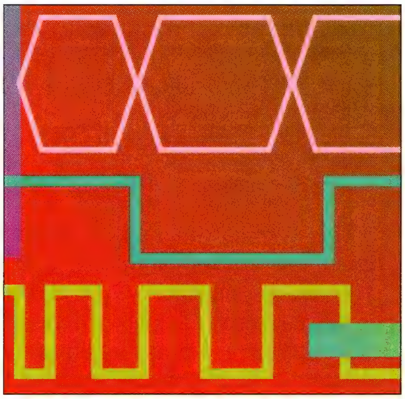

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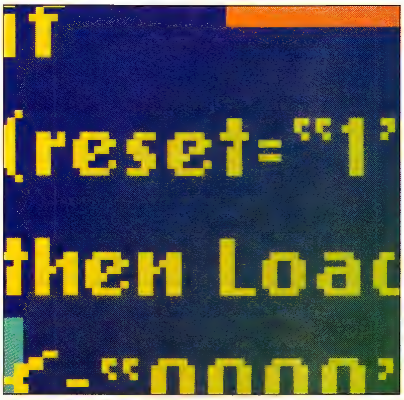

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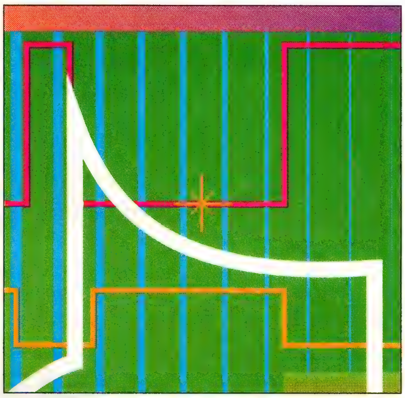

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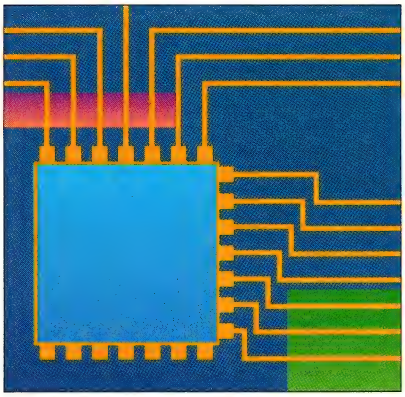

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ance of the transistor *(Fig. 3b)*. Also, replace the $g_m v_\pi$ generator with an equivalent dependent source of value $G_M V_1$. Remember that the input resistance of an emitter follower is:

$$R_{in} = r_x + r_\pi + (1 + h_{fe})R_E \tag{5}$$

Given this result, the resistance R_1 at node V_1 is:

$$R_1 = r_\pi + (1 + h_{fe})R_E \tag{6}$$

To project this result back to the original circuit, you need to solve for v_π by solving the current divider:

$$v_\pi = I_T \frac{r_\pi(R_s + r_x)}{R_s + r_x + r_\pi + (1 + h_{fe})R_E} \tag{7}$$

Similarly, the voltage at V_1 is equal to the current I_T multiplied by the total resistance at node V_1. This resistance is $R_s + r_x$ in parallel with R_1:

$$V_1 = I_T \frac{(R_s + r_x)(r_\pi + (1 + h_{fe})R_E)}{R_s + r_x + r_\pi + (1 + h_{fe})R_E} \tag{8}$$

The new circuit has replaced the dependent current source $g_m v_\pi$ by an equivalent generator $G_M V_1$. However, the currents of the two dependent current sources must be equal. Given the previously found results, this means that you can solve for the new G_M:

$$G_M = g_m \frac{v_\pi}{V_1} = g_m \frac{r_\pi(R_s + r_x)}{(R_s + r_x)(r_\pi + (1 + h_{fe})R_E)} \tag{9}$$

Because h_{fe} is much greater than 1 (and g_m is much greater than $1/v_\pi$), this reduces to:

$$G_M \approx \frac{g_m}{1 + g_m R_E} \tag{10}$$

Now that you've figured out G_M and V_1 for the simpler circuit, you need to solve for that circuit with the usual techniques. R_{EQ1} is the equivalent resistance seen between the V_1 node and ground:

$$R_{EQ1} = (R_s + r_x) \| (r_\pi + (1 + h_{fe})R_E) \tag{11}$$

You need to solve for V_1 and V_2, because the resulting test voltage V_T is equal to $V_1 - V_2$. The node voltage V_1 is easily found:

$$V_1 = I_T R_{EQ1} \tag{12}$$

Node V_2 is not so difficult:

$$V_2 = -(I_T + G_M V_1)R_L \tag{13}$$

$$V_2 = -I_T(1 + G_M R_{EQ1})R_L \tag{14}$$

The open circuit facing C_μ is found by:

$$R_{2o} = \frac{V_1 - V_2}{I_T} \tag{15}$$

yielding the *final* result:

$$R_{2o} = R_{EQ1} + R_L + G_M R_L R_{EQ1} \tag{16}$$

$$G_M \approx \frac{g_m}{1 + g_m R_E} \tag{17}$$

$$R_{EQ1} = (R_s + r_x) \| (r_\pi + (1 + h_{fe})R_E) \tag{18}$$

In Equation 16, you can see the Miller effect reflected in the $G_M R_L R_{EQ1}$ term. For a high-gain amplifier ($G_M R_L$ large), this term will dominate. The effects of the emitter-degeneration resistor R_E are shown in Equation 17, where the effective g_m of the transistor is reduced.

The results take on physical significance when you make some important approximations based on the specific circuit topology. For the emitter follower, there's no collector load resistor ($R_L = 0$). Furthermore, the emitter load resistor is usually large compared to r_x and r_π. In the limit where the emitter follower is biased with a current source (in other words, R_E becomes infinite, or very large compared to r_x, r_π, and the source resistance R_s), the time constant for C_π reduces to:

$$R_{1o} \approx \frac{1}{g_m} \tag{19}$$

The R_{1o} time constant is very small because of the bootstrapping effect of the relatively large emitter resistor R_E.

For C_μ, no Miller-effect effective resistance exists, and the open circuit resistance is:

$$R_{2o} = (R_s + r_x) \| (r_\pi + (1 + h_{fe})R_E) \tag{20}$$

Again, if the emitter follower has a large emitter resistor (if $h_{fe}R_E$ is much greater than R_s, r_x, and r_π), this may be approximated as:

$$R_{2o} \approx R_s + r_x \tag{21}$$

For a high-gain common-emitter amplifier, the Miller effect is reflected in the open-circuit time constant. Given $R_E = 0$, the C_π open-circuit resistance reduces to:

$$R_{1o} = r_\pi \| (R_s + r_x) \tag{22}$$

If $R_s + r_x$ is small compared to r_π, the dominant term in Equation 22 is the effective source resistance. The C_μ time constant is:

$$R_{2o} = R_L + (1 + g_m R_L)\left[(R_s + r_x) \| r_\pi\right] \tag{23}$$

Equation 23 again shows the familiar Miller effect term.

These equations should be used as a guideline when making approximations. Every circuit is different, so be prepared to make your own calculations. To summarize, useful techniques when faced with a complicated circuit are:

- Solve it by thinking, not by working too hard.
- Break a difficult problem into several easier ones, and then solve the various parts.
- Convert the circuit to an already solved form.
- Make reasonable approximations.☐

Marc Thompson is a senior engineer at Polaroid's Medical Imaging Systems. He has a BS and MS in electrical engineering from the Massachusetts Institute of Technology, Cambridge, and is currently pursuing his PhD.

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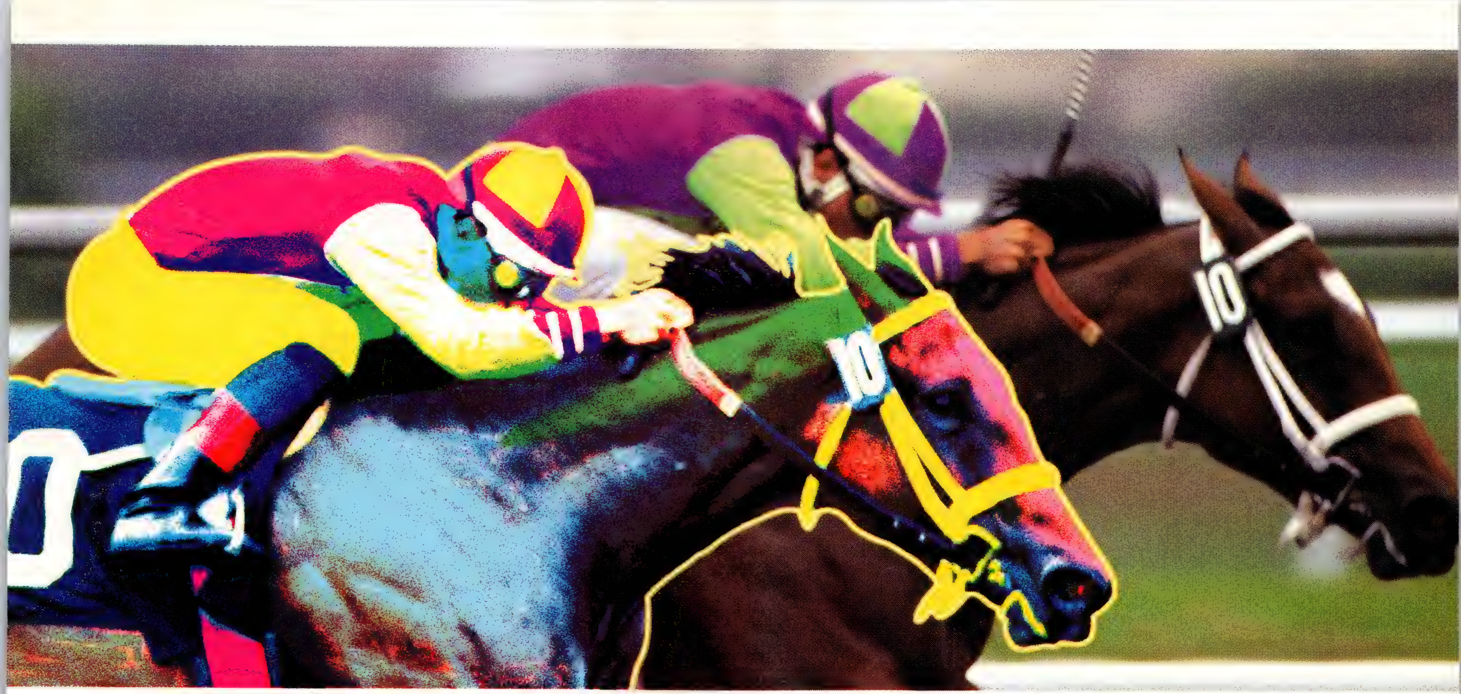
SLIGHTLY	532



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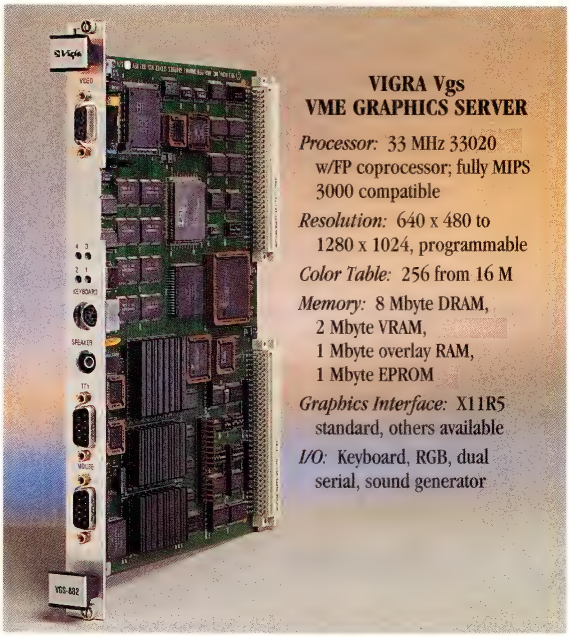

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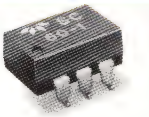
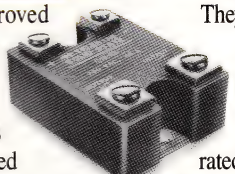
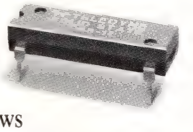


Surface Mount Shown

Housed in a 6 pin mini-DIP, the C60 Series is a family of bi-directional FET output solid state relays capable of controlling ac, bi-directional or dc loads. The optically coupled C60 handles a broad range of switched voltages (up to ±360 Vdc) and currents (up to 1.0 Arms /2.0 Adc). The unique three terminal output allows the user to parallel the output FETs externally for dc operation ensuring low on resistance down to 0.075 ohms.

C45





The C45 has a significantly improved price/performance ratio. This series of solid state ac relays are optically isolated. The units contain back-to-back photo SCRs and a zero crossing circuit developed by Teledyne. The tight zero switch window ensures reliable transient free switching of AC loads and very low EMI and noise generation. The optical isolation of control from output affords noise free power switching. This series can switch from 10 ma to 1.0 amp rms at 250 Vrms. The C45 is packaged in a low profile 16 pin DIP package.

C15

The C15 ac solid state relays are truly valued engineered, employing back-to-back SCRs with a zero crossing turn on circuit. They also provide transient free switching of AC loads and very low EMI and noise generation. This series of solid state relays has versions rated from 10 to 40 amp rms at 250 V rms. These units are packaged in the familiar industry standard configuration.

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CIRCLE

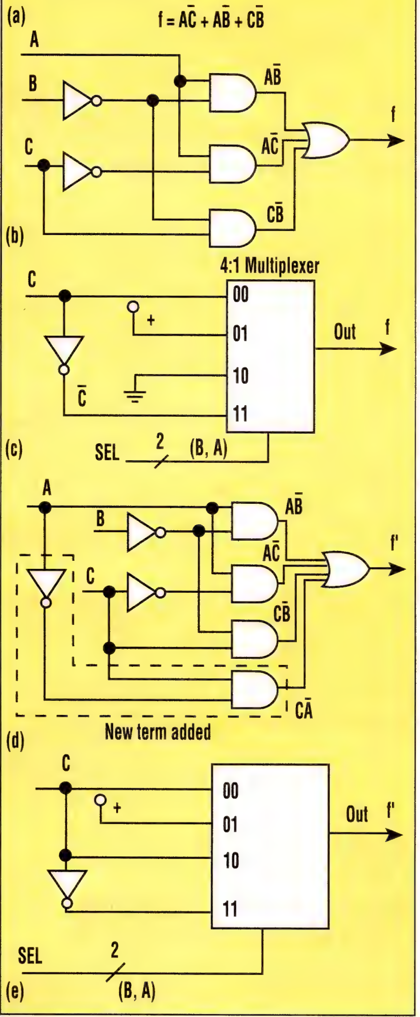
521

MUX IMPLEMENTS COMBINATORIAL LOGIC

DAVID L. ALBEAN
Thomson Consumer Electronics, 600 N. Sherman Dr., MS 1-399,
Indianapolis, IN 46201.

TRUTH TABLE

C	B	A	Function out
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0



COMBINATORIAL logic can be implemented simply by using a multiplexer instead of logic gates. Shown are the truth table (a), its logic circuit (b), and the multiplexer connections (c). If the logic circuitry is changed (d), the multiplexer would be reconnected (e).

A multiplexer can be used to implement combinatorial logic circuits in a straightforward and efficient manner *(see the figure, a)*. This technique comes in handy when building a breadboard. Another logic function is needed, but you'd rather not add extra logic packages to the board.

In addition, the technique allows for easy modification of the logic function. Instead of changing the entire logic circuit, a simple reconnection of the multiplexer inputs is all that's needed.

For example, a 4:1 multiplexer can implement any arbitrary logic function of three input variables, and an 8:1 multiplexer handles four input variables. Larger multiplexers should be used to deal with larger numbers of input variables.

To implement the desired logic function, the following technique is used: Consider a 4:1 multiplexer to be used to implement the truth table shown, for the logic function *(see the figure, b)*:

$$f = A\overline{C} + A\overline{B} + C\overline{B}$$

Examine the truth table for the desired function. Use the LSBs (A and B) as the multiplexer select bits *(see the figure, c)*. Compare the MSB (C) to the function output for both occurrences of the LSB pattern. If the output should be a "1" for both combinations, simply tie that input of the multiplexer high. If it's "0," tie the input low. If the output is the same as the MSB, tie that input to the MSB. Finally, if the output should be the inverse of the MSB, add an inverter and tie the inverted MSB to that multiplexer input. For instance, look at the two cases of $A = B = 0$. For $C = 0$, function out $= 0$; for $C = 1$, function out $= 1$. Thus, the "00" input of the multiplexer should be tied to C.

It's also easy to modify the logic function. Suppose the entry for $CBA = 110 = 0$ is changed to $CBA = 110 = 1$. The logic equation takes on an extra term, $C\overline{A}$:

$$f' = A\overline{C} + A\overline{B} + C\overline{B} + C\overline{A}.$$

This extra term is shown with dashed connections in the circuit *(see the figure, d)* and the multiplexer is rewired *(see the figure, e)*.

This technique is extended to larger multiplexers by always using the LSBs of the inputs as the multiplexer selects, and using the MSB to determine how to connect the selected input via the aforementioned algorithm. Note that for a function of n input variables, a mux with $2^{(n-1)}$ inputs is required.☐

CIRCLE

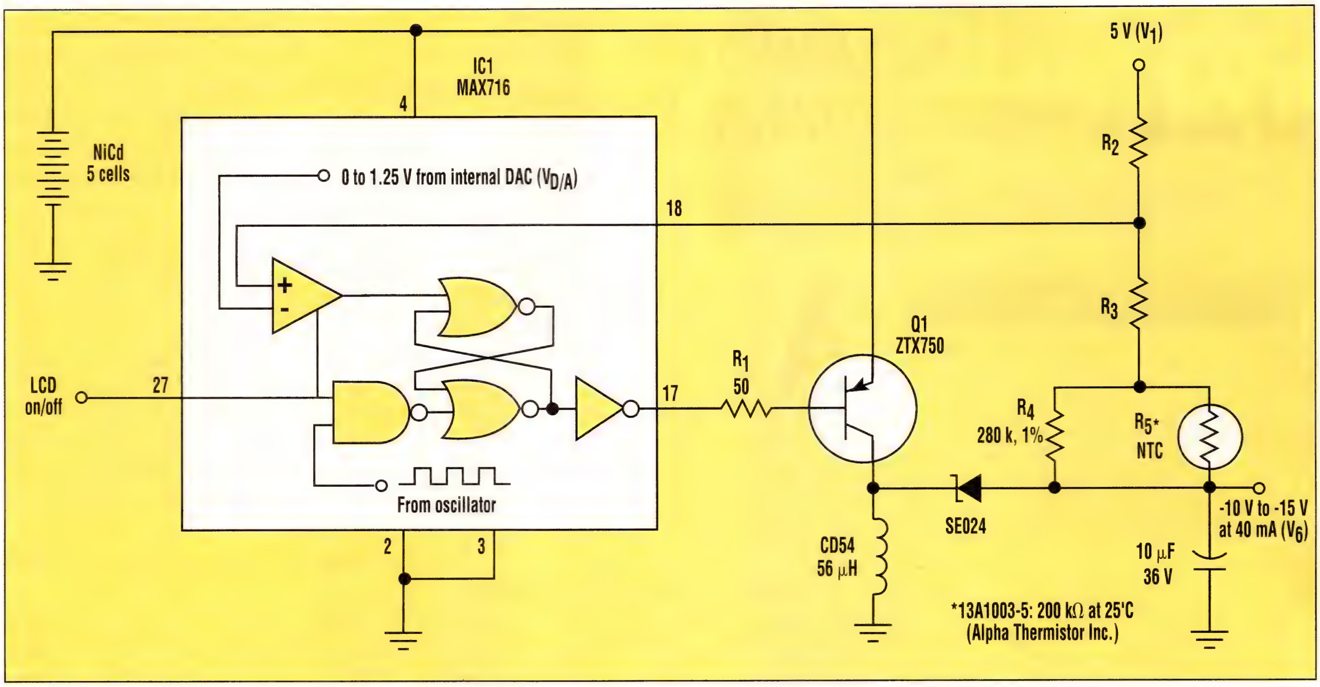
522

TEMP COMPENSATION LEVELS LCD CONTRAST

DOUG VARGHA
Maxim Integrated Products, 120 San Gabriel Dr.,
Sunnyvale, CA 94086; (408) 737-7600.

The variation of LCD contrast with temperature can become a problem in some applications. For instance, when working in a meat-packing plant, you might go from scanning sides of beef in a refrigerated locker to downloading data from your LCD bar-code reader in a heated office. That type of drastic temperature change would definitely require an LCD-bias adjustment.

By combining automatic bias adjustment with manual-adjust capability, the user can compensate for LCD viewing angles and manufacturing differences *(Fig. 1)*. IC1 is a power-supply chip for portable systems, and it includes two other switching-regulator controllers plus four linear-regulator controllers, plus circuitry for backup-battery switchover, low-voltage warning, and power-fail reset. When using



1. THE NEGATIVE TEMPERATURE-COEFFICIENT resistor R_5 modifies feedback in this switching regulator, which results in a negative output voltage that varies with temperature. With properly chosen resistor values, the circuit produces a temperature-compensated bias voltage that assures constant contrast in an LCD.

this setup, the circuit provides a linear bias change with temperature, from –10 V at 50°C to –15 V at –20°C *(Fig. 2)*.

The automatic compensation is supplied by a negative-temperature coefficient resistor (R_5) that affects the feedback for the LCD-bias-voltage (V_6) regulator in IC1. Decreasing temperature, for example, causes an increase in R_5's resistance and a consequent increase in the V_6. R_4 linearizes the effect of R_5, and R_3 adjusts the temperature coefficient of R_5 to that of the LCD (other temperature coefficients require different values for R_2 and R_3).

When calculating R_2 and R_3, first note that V_6 is a function of $V_{D/A}$ and R_T. $V_{D/A}$ is the output of the internal 5-bit DAC, which enables the user to digitally adjust the LCD bias voltage. Also, R_T is the sum of R_3 and the parallel combination of R_4 and R_5. In equation form, it's as follows:

$$V_6 = V_{D/A} - (5\text{ V} - V_{D/A})R_T/R_2$$

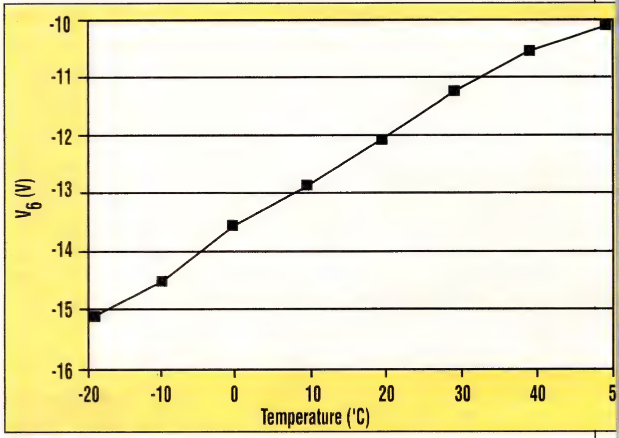
Therefore,

$$R_T = R_2(V_{D/A} - V_6)(5\text{ V} - V_{D/A})$$

Solve for R_T at the extremes of V_6 (–10 V and –15 V) using the midrange value for $V_{D/A}$ (0.625 V): $V_6 = -10$ V, $R_T = 2.43R_2$; $V_6 = -15$ V, $R_T = 3.57R_2$.

Equivalent expressions for R_T are based on its definition: $V_6 = -10$ V, $R_T = R_3 + (R_5 @ 50°C)||R_4$; $V_6 = -15$ V, $R_T = R_3 + (R_5 @ -20°C)||R_4$.

From the R_5 data sheet, $R_4 = 277$ kΩ (choose 280 k, 1%), R_5 @ 50°C = 52.7 kΩ, and R_5 @ –20°C = 250.1 kΩ. With that information, substitute those values in the previous equations, equate corresponding expressions for R_T, and solve for R_2 and R_3. As a result, R_2 = 172 kΩ (use 169 kΩ, 1%); R_3 = 365 kΩ (use 365 kΩ, 1%).□



2. THE REGULATOR OUTPUT in Figure 1 serves as a temperature-compensated bias voltage for LCDs.

CIRCLE 523

PHOTODIODE-AMP NULLS AMBIENT LIGHT

R. MARK STITT and WALLY MEINEL
Burr-Brown Corp., 6730 S. Tucson Blvd., Tucson, AZ 85076.

Many applications use a photodiode to measure a light signal in the presence of ambient background light. Sometimes, the photodiode can be optically shielded from background light to eliminate unwanted signals. Another solution is to use a photodiode-amplifier with a dc-restoration circuit to reject low-frequency background light signals.

The circuit shown represents the

latter method *(see the figure)*. It consists of a Burr-Brown OPT201 integrated photodiode and amplifier, and an external op amp for dc restoration. The OPT201 combines a large 0.090-by-0.090-in. photodiode and a high-performance transimpedance amplifier on one chip. This composite eliminates the problems common among discrete designs, including leakage current errors, noise pickup, and gain peaking due to stray capacitance. The dc-restoration circuit consists of a noninverting integrator driving the transimpedance-amplifier summing junction through a 100-kΩ resistor, R_3. The current through R_3 cancels the current from the photodiode at signal frequencies below integrator's pole frequency to drive the output of the photodiode amplifier to 0 V. The pole frequency is set by R_2 and C_2:

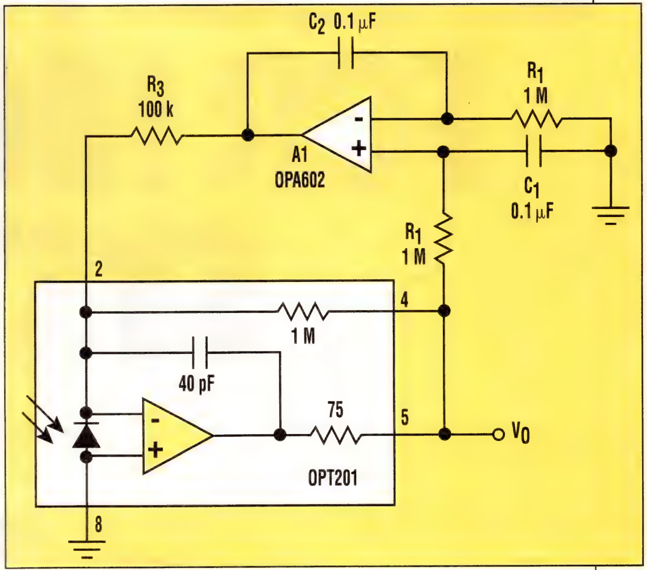
$$f_{-3\,db} = (1\ \text{M}\Omega)/(2\pi R_2C_2R_3)$$

The 1-MΩ, 0.1-µF values shown in the figure for R_2 and C_2 set the low-frequency cutoff pole at 16 Hz. Because of the long time constant, it may take more than one second for the circuit to come out of saturation when first powered up.

A noninverting integrator requires a matching pole. The matching pole, set by R_1 and C_1, prevents photodiode-amplifier output signals above the pole frequency from feeding directly back into the summing junction of the transimpedance amplifier. Matching the poles isn't critical—±30% tolerance is adequate for most applications.

The value used for R_3 depends on the amplitude of the background light. With a 10-V output on A1, the 100-k resistor can provide a 100-µA restoration current. This represents ten times the photodiode current that would otherwise drive the photodiode amplifier into saturation when using the internal 1-MΩ resistor. The dc-restoration circuit can remove a background signal many times larger than the ac signal of interest, thus supplying the increased signal-to-noise level critical in many applications.

Reducing the value of R_3 will increase the dc restoration range, but will also raise the noise gain of the transimpedance amplifier. Dropping R_3 to 10 kΩ would increase noise from 130 µV rms to 650 µV rms. Values above 100 kΩ for R_3 will not substantially reduce noise.□



A PHOTODIODE amplifier combined with a dc-restoration circuit will reject low-frequency ambient background light, easing measurement of a light signal.

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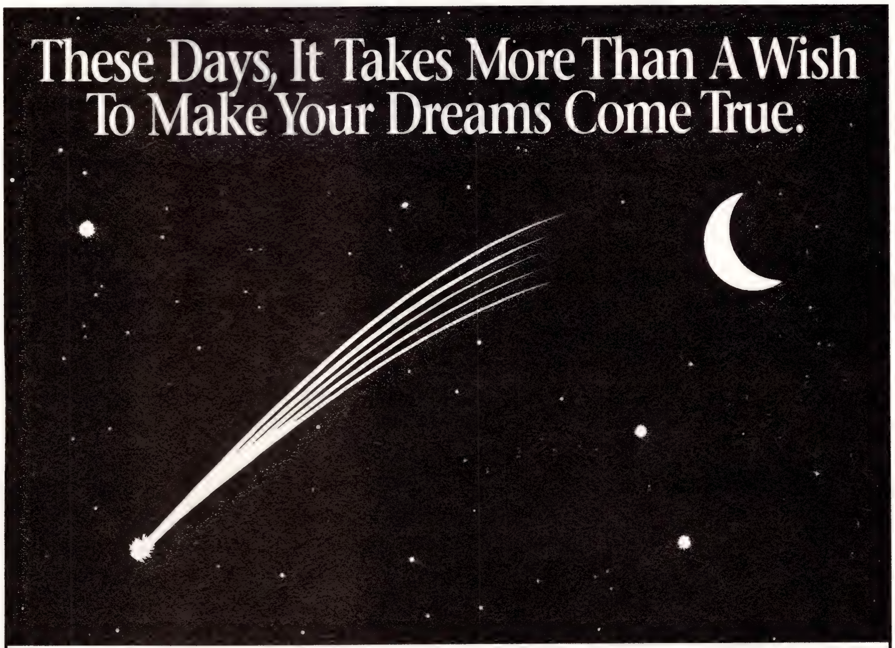
IFD WINNER

IFD Winner for August 19, 1993

Clive Bolton, Bolton Engineering Inc., 37 Washington St., Melrose, MA 02176. His idea: *"5-V-Only Circuit Generates Dial Tone."*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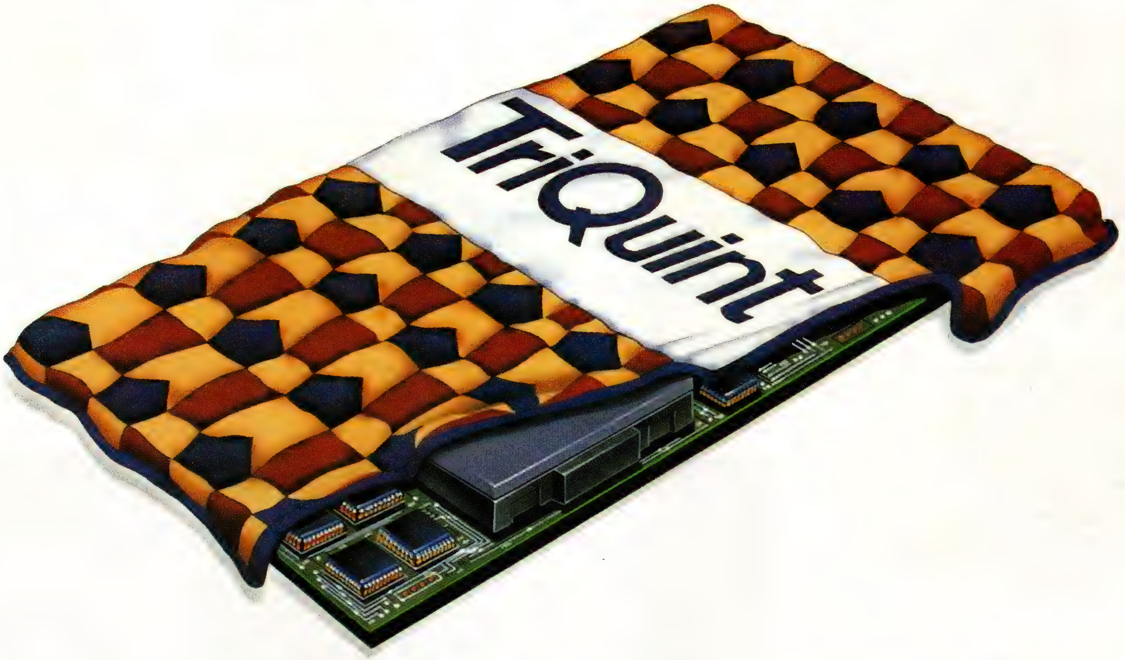

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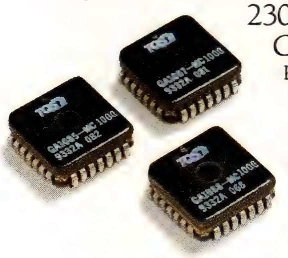

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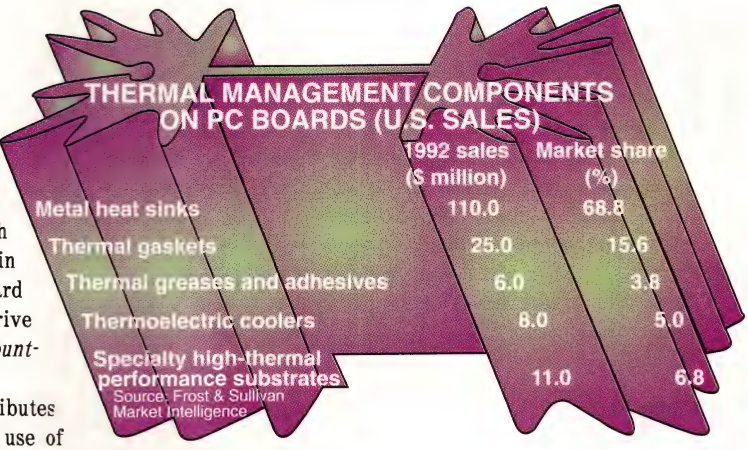
QUICK LOOK

EDITED BY SHERRIE VAN TYLE

MARKET FACTS

With ICs continuing to increase in complexity and attendant increases in power consumption, U. S. sales should keep pace for pc-board mounted thermal management components, rising from $160 million last year to hit $220 million in 1997. Also driving growth are faster IC clock speeds, which increases heat, and more use of surface mounting, which in turn boosts system power densities as well as a trend toward smaller electronic system packages. These predictions derive from Frost & Sullivan Market Intelligence's report, *PCB-Mounted Thermal Management Components.*

The Mountain View, Calif., market researcher also attributes growth to the growing popularity of multichip modules, use of thermoelectric technology, and the emergence of integrated cooling modules. The fastest growing segment is for specialty, high-thermal performance pc-board substrates, which will enjoy a 17% compound annual growth rate, achieving $24 million in sales by 1997.



THERMAL MANAGEMENT COMPONENTS ON PC BOARDS (U.S. SALES)

	1992 sales ($ million)	Market share (%)
Metal heat sinks	110.0	68.8
Thermal gaskets	25.0	15.6
Thermal greases and adhesives	6.0	3.8
Thermoelectric coolers	8.0	5.0
Specialty high-thermal performance substrates	11.0	6.8

Source: Frost & Sullivan Market Intelligence

Thermoelectric cooler growth will be fueled by growing use of multichip modules (MCMs) and emergence of integrated cooling modules using these devices. The 1992 market included $115 million for purchases of metal heat sinks, $25 million for thermal gaskets, $6 million for thermal greases and adhesives, $8 million for thermoelectric cooling modules, and $11 million for pc-board substrates.

TALES FROM A SKUNK WORKS

In industry, most agree there is a lack of leadership. The leaders of yore were creators and entrepreneurs, often with deep knowledge of technology, products, and markets. No longer. Because skunk works cannot exist without leadership, role models, and risk taking, lack of leadership causes concern. The best way to use skunk works is for your breakthrough projects. There are easier ways to make small improvements, so you want these teams to swing for the fences. You want innovation, and, unfortunately, this requires tasking risks and sometimes striking out. Babe Ruth's record for home runs—714—was phenomenal. Few remember that Ruth held another record—for more strike outs than any other player—1330.

> "Punishing the innovator when an innovation fails is the best way to ensure that no one ever attempts to be innovative."
> —Hammer and Champy, *Reengineering the Corporation*

Today's management gurus hold that competitiveness comes from the work force. We advocate higher skills, lifelong learning, and employee involvement as necessary for prosperous firms and high wage economies. You can't attend a seminar on leadership without encountering exhortations to empowerment, teamwork, partnership, and a long-term outlook. These things work, but they take time and depend upon the security to take risks.

An easier, trendier model, however, is slash and burn downsizing. The two visions obviously clash. Under slash and burn, anyone who can be laid off should be laid off. Cheap flesh robots are better than talented teams. Statistics are getting better, but new product results are getting worse. A recent *Business Week* story bemoaned too many new products failing but had little useful to say about improving the results.

Today 53% of new product development funds are spent on "successful" products, about the same as 1982 and up from 30% in 1968. But too many of the resulting "successes" are knock-off products. The PC industry is an example, frantically cycling undifferentiated, marginally successful products. In 1968 about 58 ideas were processed per new product. Today the ratio is about 11 : 1. For every 100 new product ideas, about 27 are tested; 12 introduced; and 9 succeed. This is when the firm that did the product defines success; the market is often less kind. Firms are "saving money" by considering fewer ideas. Wouldn't it be better to process more ideas?

John D. Trudel lectures and provides business development consulting. Trudel is founder and director of The Trudel Group, 52001 Columbia River Hwy., Scappoose, OR 97056; (503) 640-5599; fax (503) 543-6361; e-mail address: JohnTrudel@aol.com. He is the author of High Tech with Low Risk. *To order, phone (503) 280-8547.*

EYE ON ISO 9000

The AMP Signal Transmission Products Divsion's quality management system has received ISO 9001 certification for the group's design and manufacture of radio frequency interconnection products in Seven Valleys, Manheim, and Harrisburg, Pa. Contact AMP Inc., P. O. Box 3608, Harrisburg, PA 17105-3608; (717) 564-0100. CIRCLE 460

Integrated Device Technology Inc. has been certified for design, development, wafer fabrication, manufacture, and assembly of monolithic ICs at its three California facilities, in San Jose, Santa Clara, and Salinas. The Santa Clara, Calif.-based company designs and manufactures high-speed CMOS VLSI integrated circuits with sub half-micron feature sizes. Contact Integrated Device Technology, 2975 Stender Way, Santa Clara, CA 95054; (408) 492-8647. CIRCLE 461

Mack Molding Co., a plastics molder and manufacturer has received ISO 9002 certification for its three facilities in Vermont—Arlington, Cavendish, and Pownal. The Arlington, Vt.-based company specializes in the design, assembly, and finishing of large parts for computers, busines equipment, consumer electronics, and medical products. Contact Jeff Somple, Mack Molding Co., East Arlington Rd., Arlington, VT 05250; (802) 375-2511; fax -9491. CIRCLE 462

NCR Corp.'s Evaluation Technology Center (NCR-CETC), which supplies testing, evaluation, and procurement-related services for electrical components used by AT&T, NCR, and other clients, has received ISO 9001 registration. The Wichita, Kansas, facility relies on supply-line management techniques and information systems. NCR is an AT&T company, based in Dayton, Ohio. Contact NCR Corp., CETC, 3450 North Rock Rd., Bldg. 100, Wichita, KS 67226; (316) 636-4800. CIRCLE 463

Phoenix Contact Inc. has been granted ISO 9002 registration for its manufacturing facility in Harrisburg, Pa. The Harrisburg, Pa., company manufactures IEC/DIN-rail mounted terminal block and interconnection devices, the only such U. S. manufacturing facility with an ISO 9002 registered system. Contact Phoenix Contact, P. O. Box 4100, Harrisburg, PA 17111; (800) 888-7388 or (717) 944-1300; fax -1625. CIRCLE 464

KMET'S KORNER

...Perspectives on Time-to-Market

BY RON KMETOVICZ
President, Time to Market Associates Inc.
P. O. Box 443, 100 Prickly Pear Rd., Verdi, NV 89439; (408) 446-4458; fax (408) 253-6085

How many of you are familiar with the book *The Mythical Man-Month* by Frederick Brooks? I meet a number of engineers and engineering managers who seem to know all about it and use it as a defensive tool to make certain their projects are always understaffed and thereby always late. A common thought process goes like this . . . Staff is assigned to do a given job. Team members and managers are convinced that by adding more staff, the job will take longer. It will take longer because of communication path growth, because more management attention for work coordination is needed and because the gut knows that adding few more people won't make a difference anyway. This logic, to the best that I've been able to determine is just plain wrong! Adjusting staff levels on small (less than 10-engineer) to medium-size (fewer than 100-engineer) new product development efforts has considerable impact on time to market performance. I'll return to the examples used in the last column and work with staffing ratio misses that are much less than 50%.

Example 1: 12 months' development time with a 24-month market window, rise and fall times equal to 6 months. The new product development effort is staffed with 65 engineers instead of the 74 identified by the project manager.

r	S	d	w	a	b	Profit ratio
12	1	0	24	6	6	0.00
12	0.88	1.636	24	6	6	0.10

A 12% understaffing produces a 1.6-month delay as lifetime profits plunge by 10%. On the surface this may not look so bad, but digging a little deeper presents a different picture. This scenario is based on a workstation product that is expected to generate in excess of $100,000,000 in lifetime profits. Throwing away 10% of this money is $10,000,000 bucks! To keep the dough, all the organization needs to do is add 9 engineers for a year to get to the market on time. The costs associated with taking this action in Silicon Valley should be less than $1,400,000. Maybe spending the money to get there on time is worth it?

Some might argue that you could get the same results with the lower head count if folks just worked more. I suggest that understaffing from the start is a bad practice. I've never seen a new product development effort yet that contained less work than the management team and the team members thought it would. Things always grow in complexity; things always go wrong; and Murphy laughs! A prudent organization sensitive to time to market deals with unknown work by staffing correctly from the start. So the team can put in the extra effort to deal with the unexpected and still get done on time. Running the effort understaffed and overworked from the beginning is a sure prescription for delayed market entry.

Example 2: 9 months' development time with a 12-month market window, rise and fall times equal to 3 months. Staffing is limited to 8 engineers; the team members and the project manager identified the need for 9.

r	S	d	w	a	b	Profit ratio
9	1	0	12	3	3	0.00
9	0.9	1	12	3	3	0.13

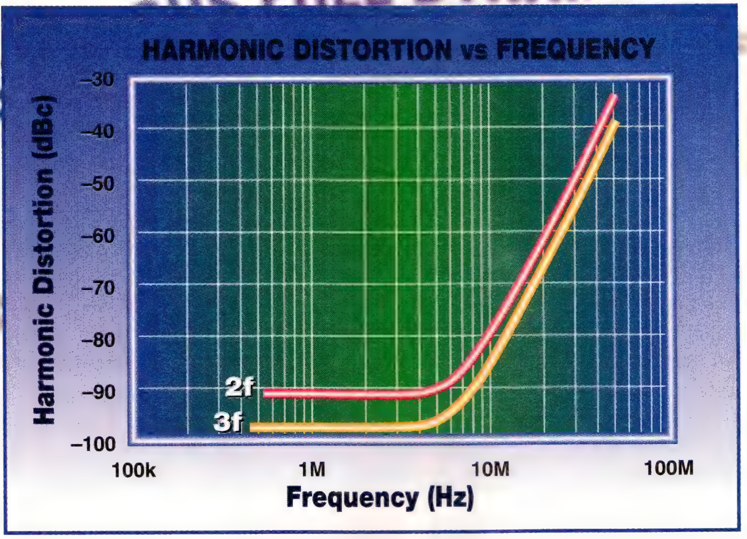
This example is based on a scenario that might be encountered by Seagate, Maxtor, Quantum, or Conner. Running one engineer light can cost one month in time and millions in lifetime profit. Getting staffing and timing right should cost no more than $250,000.

For homework, measure the staffing ratio on a key new product program now in process. Once known, do what needs doing to get it right.

More information on this topic is contained in New Product Development: Design and Analysis, which can be obtained by calling Time to Market Associates.

New Op Amp Delivers 160MHz Bandwidth and 90dB SFDR

90dB SPURIOUS FREE DYNAMIC RANGE



Designed for Low Distortion

OPA628 is a unity gain stable, voltage feedback op amp that delivers 160MHz bandwidth and 90dB SFDR. Its classic op amp design features high input impedance, high common mode rejection, and symmetrical differential input flexibility. Its 90dB SFDR means excellent linearity—better than 1LSB of 15 bits. And, it's powered by ±5V supplies for low power dissipation. Designed for low distortion, OPA628 is your performance choice.

Designed for Versatility

OPA628's versatility, performance, and low price make it perfect for precision video, telecommunications, instrumentation, and test equipment applications. It's an ideal precision A/D and D/A buffer. It's a great driver for 12- to 16-bit high speed A/Ds. And, its 30MHz gain flatness and very low differential gain/phase error is super for high end video. Or, try it in any application that needs wide dynamic range. Designed for versatility, OPA628 fits your next application.

Designed for Less

OPA628 is designed to give you optimum performance at a super price. It's a better solution than any other "make" or "buy" amp out there. Designed for savings plus performance, OPA628 is the best for less.

OPA628 Key Specifications

Low voltage noise	2.5nV/$\sqrt{Hz}$
Low noise figure	9.3dB
SFDR	90dBc
Two-tone third-order intercept	60dBm
Supply range	±4.5V to ±6V
Unity-gain bandwidth	160MHz
Differential gain/phase	0.015%/0.015°
Offset voltage	500μV
Packages	8 pin-DIP and SOIC

- Evaluation board with sample available

FREE Samples Fast

For your FREE SAMPLE, detailed data sheet, and *Operational Amplifiers* brochure—just fax **1-602-741-3895.** Or, contact your local sales rep for more information.

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QUICKLOOK

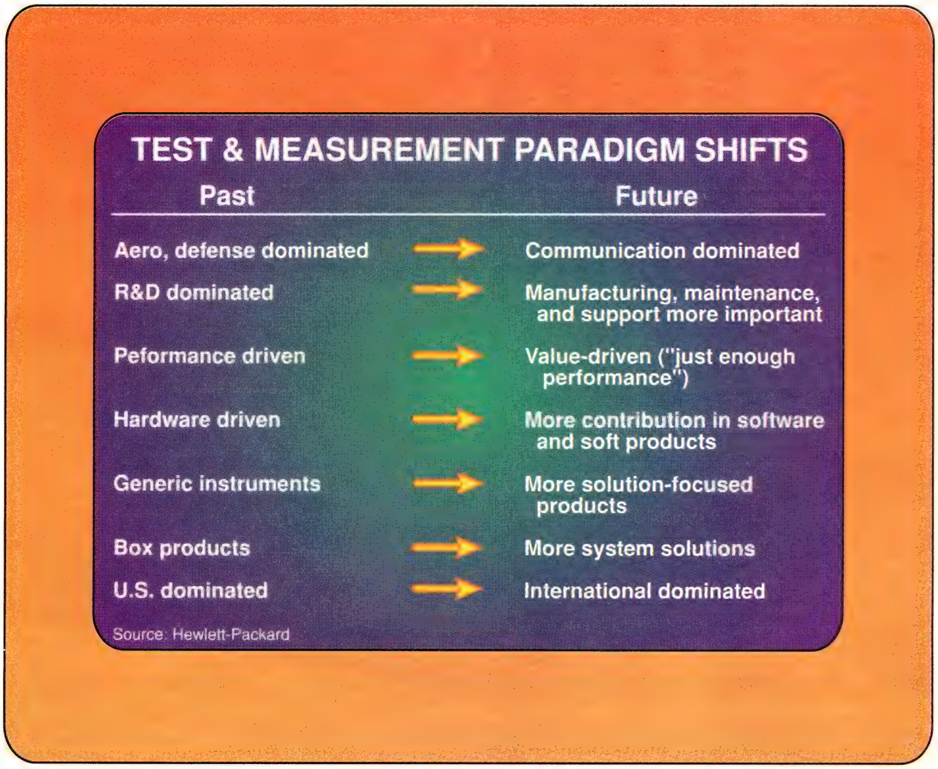
QUICK NEWS

Network security has often been breached because users rely on such traceable passwords as a birthday, a nickname, or a pet's name. An Automated Password Generator, specified in NIST's Federal Information Processing Standards Publication 181, produces random passwords that are pronounceable, easily remembered, stored, and entered into computer systems. Yet they are not readily susceptible to automated techniques developed to search for and disclose passwords. Use of the alogrithm adds an extra layer of security to protected computing resources. The standard complements the Password Usage Standard (FIPS 112, which goes for $19.50 on paper), which specifies basic security criteria for the design, implementation, and use of passwords. Copies of FIPS PUB 181 will be available for purchase from the National Technical Information Service, Springfield, VA 22161; (703) 487-4650.

JobHunt software gives information on 5000 companies, which can be searched by region, job function, or SIC code. The program has a built-in telephone dialer and word processor and also is compatible with WordPerfect and other programs. The software prints mailing labels and envelopes; users can add their own list of addresses to the databank. Copies are $54.90, including shipping with discounts for multiple copies. Contact Scope International Inc., Dept. FLR, P.O. Box 25252, Charlotte, NC 28229-5252; 9800) 843-5627 or (704) 535-0614; fax -0617. CIRCLE 465

DID YOU KNOW?

. . . that one in five personal computer programs is a copy. Overall losses to piracy of software was estimated to amount to $1.2 billion in 1991 in the U. S., down 41% from 1990's losses of $2.0 billion. Nonetheless, the loss amounts to more than the cumulative revenues of 81 of the top 100 software publishers. *Source: the Software Publishers Assoication, Washington, DC 20036; (202) 452-1600*



TEST & MEASUREMENT PARADIGM SHIFTS

Past		Future
Aero, defense dominated	→	Communication dominated
R&D dominated	→	Manufacturing, maintenance, and support more important
Peformance driven	→	Value-driven ("just enough performance")
Hardware driven	→	More contribution in software and soft products
Generic instruments	→	More solution-focused products
Box products	→	More system solutions
U.S. dominated	→	International dominated

Source: Hewlett-Packard

HOT PC PRODUCTS

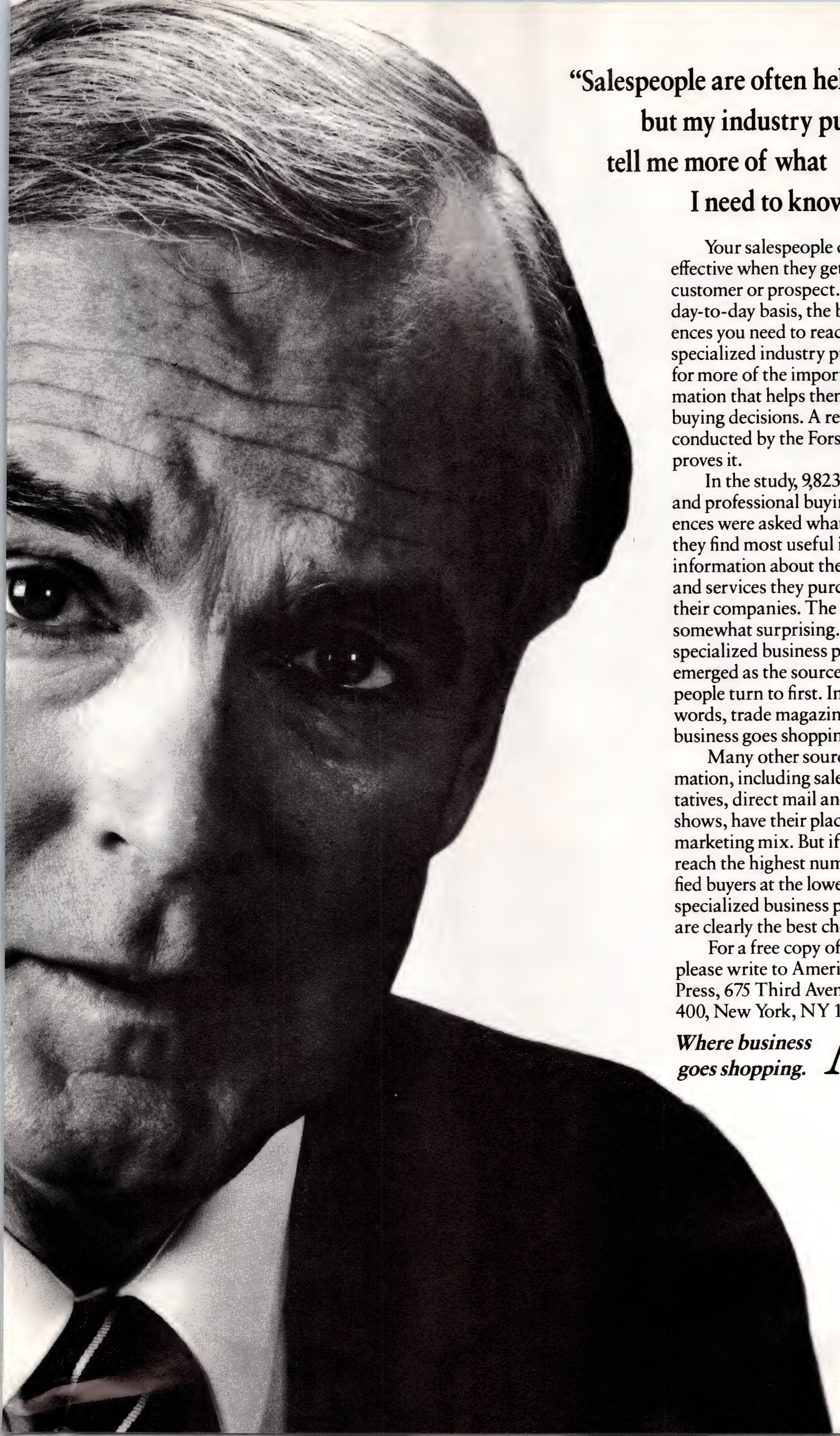
The Konexx Konnector Kit eases modem communication while traveling; the kit has a high-speed acoustic telephone coupler that plugs into the phone line jack on a modem, a 7-ft. modular cable, modular cable with alligator clips, Merlin phone adapter, screwdriver, extra 9-V battery, and a carrying case. List price for the kit is $169. Unlimited Systems Corp. also makes Konexx Konnector Model 109, a desktop adapter that connects in the handset jack and supplies an RJ-11 connection for modems, including line-powered types ($139). The Model 112 connects into the phone's handset jack and provides an RJ-11 connection for modems, except line-powered models ($149). Model 204 lists for $149. Contact Unlimited Systems Corp. Inc., 8586 Miramar Pl., San Diego, CA 92121; (800) 275-6354. CIRCLE 466

Engineers who travel between U. S. cities may find helpful software that describes locations of hotels, restaurants, and landmarks in Chicago, Los Angeles, New York, San Francisco, and Washington, DC. Taxi pinpoints any given address on a city map, constructs routes to find the address, and identifies hotels and restaurants according to Zagat criteria. Taxi, which runs on a 386 IBM PC or compatible under Windows 3.1 with 4 Mbytes of RAM, lists for $69.95; a CD-ROM version goes for $79.95. For more information, contact News Electronic Data, 28 Center St., Clinton, NJ 08809; (800) 439-8294 or (908) 735-2555. CIRCLE 467

OFFERS YOU CAN'T REFUSE

Write for a free sample copy of the *American Engineer*, a newsletter dedicated to enhancing the engineering profession and U. S. engineering capabilities. Also included is a brochure about AEA and its goals. The association's organizers point out that it is organized and maintained by experienced engineers and is different from other, typically academically driven, engineering societies. Membership in AEA costs $30 a year, which includes a year's subscription to the newsletter. To expedite the request for a sample copy of the newsletter, send a self-addressed, stamped envelope to AEA, P. O. Box 820473, Fort Worth, TX 76182-0473; or phone (817) 431-1319.

Brownouts, Blackouts, and Burnouts" is a new training video offered by SSAC Inc., a manufacturer of solid-state industrial controls. The training video covers 3-phase voltage faults and the increasing need for voltage fault protection. The 24-minute video contains diagrams and animations aimed at those who design with, maintain, use, or install 3-phase motor-powered equipment. The video is available free of charge by contacting Dave Eastwood at SSAC Inc., P. O. Box 1000, Baldwinsville, NY 13027; (315) 638-1300; fax -0333. CIRCLE 468



“Salespeople are often helpful, but my industry publications tell me more of what I need to know.”

Your salespeople can be effective when they get to see a customer or prospect. But, on a day-to-day basis, the buying influences you need to reach turn to specialized industry publications for more of the important information that helps them make buying decisions. A recent study, conducted by the Forsyth Group, proves it.

In the study, 9,823 business and professional buying influences were asked what sources they find most useful in providing information about the products and services they purchase for their companies. The results were somewhat surprising. Overall, specialized business publications emerged as the source business people turn to first. In other words, trade magazines are where business goes shopping.

Many other sources of information, including sales representatives, direct mail and trade shows, have their place in the total marketing mix. But if you want to reach the highest number of qualified buyers at the lowest cost, specialized business publications are clearly the best choice.

For a free copy of the study, please write to American Business Press, 675 Third Avenue, Suite 400, New York, NY 10017.

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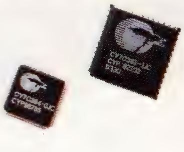

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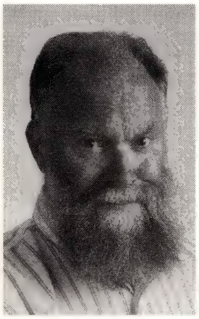
PEASE PORRIDGE

WHAT'S ALL THIS FLOOBYDUST STUFF, ANYHOW? (1993)

As we mentioned in this column a year ago, "floobydust" is a recently-coined term for "miscellaneous" or "potpourri," a regular jumble of ideas. Am I wrong??

- Back on March 4 (ELECTRONIC DESIGN, p. 108) I wrote that the Electronics Flea Market at Foothill College in Los Altos, Calif., runs on the second Saturday of every month from April through October. Unfortunately, the last Electronics Flea Market of the season is September. Hope I didn't mislead you too badly. (I wished there was one in October, but I guess the guys who run it have a right to take a break.)



BOB PEASE OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

- Also in March, on the same page, I indicated that you could buy a plastic raincoat for your camcorder for only $150. NOT a great buy. Last month, I was wandering through Fry's, a very good electronics store in Sunnyvale, Calif.,[1] and I found a raincoat for small camcorders that I could afford—$14.95—for model V-0794, by Ambico. Rather than an expensive optically flat glass front, it just has an open hood. I've used an umbrella while shooting with my camcorder in light rain, and this should work at least as well. It will be a lot lighter and more compact. If your camcorder is less compact than 10 inches long, contact the manufacturer[2] for advice on what model will fit your machine.
- I'd *like* to be able to tell you about a simple circuit for recharging your alkaline flashlight batteries. A reader in New Zealand clipped it out of a British electronics magazine[3]. It proposed that a forward pulse of charging current followed by a negative pulse would be compatible with the alkaline's chemistry and work sufficiently, as opposed to a dc recharging current, which works badly. I'd *like* to be able to recommend this circuit, but when I built it and checked it out, it ran badly. So far, I haven't been able to make it work adequately. If I can make it work, I'll let you know.
- I placed an order for a "Supercharger" that's supposed to be able to recharge ordinary alkaline flashlight cells. They said it would take 8 weeks, and that is true. I ordered it in August and it's now the end of November, and I'm still waiting. If I can get it to work, I'll let you know, and how well. It may be an improved variation of the circuit in the previous paragraph. About $59.
- I also bought a Ray-O-Vac "Renewal" recharger ($30) for charging up the Ray-O-Vac "Renewal" alkaline batteries[4]. Allegedly, these can be recharged 25 times. However, each time you recharge the battery, the capacity shrinks a little more. Even though you recharge the battery 25 times, you only get as much energy as 8 new batteries. Still, if you use a lot of Alkaline batteries, this could pay for itself fairly quickly. Even as cell capacity decreases, the cell still holds 3X or 2X or 1X as much as a good NiCd battery, which costs more but can be recycled more than 100 times. So the Ray-O-Vac Renewal system can definitely save you some money compared to throwing away flashlight batteries. It may also have advantages if NiCds aren't suitable. However, I've tried several times to get basic technical information from Ray-O-Vac, and they have yet to respond.
- As I mentioned earlier, I think I can recharge my camcorder's NiCds on long hiking trips with a special high-efficiency switch-mode regulator that uses Alkaline D-cells as the main energy source. Alkalines hold 3X more energy (per ounce) than just carrying more NiCds. However, we've been too busy to build this switcher, so that will have to wait a little more. Sigh. Meanwhile, on my summer back-packing trips, I just carried my old hand-crank gear-motor, and it continued to work well.
- A friend tipped me off to the advantages of zinc-air batteries.[5] These can put out 2X more energy per ounce than alkaline D cells, which in turn can put out 5X more energy than lead-acid cells, or 3X more than NiCds. So you could use 1 pound of zinc-air cells to recharge 1 pound of NiCds six times! That sounds like the way to go, except that if you try to draw too much current from the zinc-air cells, they go to pot. If you really want to get the full energy from a zinc-air cell, you have to spread that energy transfer *very carefully* out over 200 hours. In other words, they're not ideal for a fast recharge. Also, they're not cheap—maybe cheaper than lithiums, but cost per watt-hour is higher than alkaline D-cells; and availability is quite poor, special order and all that.
- Several people asked, "Why do you *have to* double-clutch a VW?" I had to reply, you do not *have to*, but it is fun, it sounds and feels right, and keeps you in practice. One reader said that, when starting up in traffic, he doesn't just shift from neutral into first, but from neutral to second to first. In a car without synchromesh on first gear, this saves on wear and tear. I confirm that I also usually do that, just to share the wear on all of the synchronizers—even though I don't have to. Also, I have a habit, after I shift into fourth gear, to reach down and check my handbrake to make sure

it is *off*. About 99% of the time it *is* off. Just a precaution.

- April is coming, and we shall have a fine kettle of hoaxes in the April 1 issue. Meanwhile, those of you who are thoughtful about audio equipment will be pleased to learn of *The Audio Critic* magazine.[6] It debunks various myths and ridiculous claims about super-high-end audio equipment, when claims are made that obviously can't be proven but rather must be accepted on faith. If you could use an occasional sanity check, their magazine (quarterly) is a good investment. Their "Hip Boots" column is priceless.
- I got dozens of checklists from readers, hiking checklists and lists for business trips, with lots of interesting ideas. I sent out dozens of my basic lists, too. On my back-packing checklist, I have amended it to reject any shirts with less than 27 inches from the top of the shoulder to the bottom of the side seam. Shirts shorter than that tend to not stay tucked in, and are uncomfortable.
- A friend up in Oregon suggested that if you want to get a floating scope with low capacitance to ground, the Fluke Model 97 is quite compact.[7] It has less than 8 pF, much less than most scopes. This low capacitance can help improve rejection of ground noises.... In the old days, if you really wanted to get the best isolation of a circuit, you did not use a Teflon spacer. Instead, you hung your circuit from a silk thread. I once measured some silk thread. I figured out that a 3-inch piece of silk thread has a resistance of about 3×10^{15} ohms in dry weather, and a capacitance about 0.02 pF more than the air itself. Not bad. The Fluke 97 weighs only four pounds, and needs only about eight strands of silk thread....
- Doctor Science has a brand new book out, just in time for Christmas: *Dr. Science's Book of Shocking Domestic Revelations*—marvelous lunacy and advice on home repairs and construction.... Very reasonable at $17.50 (includes shipping).[8] To order, call 1-800-989-DUCK. If you want to order on CD-ROM, hold your breath and count by ones to 6×10^{23}. It should be ready by then.
- In the field of battery charging and alternative energy, I recommend *Home Power—The Hands-on Journal of Home-Made Power*.[9] This is good reading for people who are interested in cost-effective systems, not the fancy battery-power systems that only a marijuana-grower can afford. Practical insights. Low smarm content. Examples of good engineering using recycled, home-engineered parts for thoughtful cost-effective systems. It's well-written and doesn't insult your intelligence.
- I have heard that Whirlpool's $30-million prize-winning high-efficiency refrigerator is supposed to use Fuzzy Logic. One report claimed that it uses F.L. "to make the compressor more efficient." But another guy said, baloney—it just uses F.L. to reschedule the Defrost cycle so it won't waste energy doing a Defrost if no Defrost is needed. Does anybody know what the truth is?
- Most F.L. controllers that we see have one input for (x) and one input for (dx/dt). The Fuzzy guys thus have two knobs. I usually run my controller with one input for x, one for dx/dt, and one for $\int x \cdot dt$. So I have three paths, commonly known as Proportional, Integral, Derivative (usually called PID), and thus I have 3 knobs. The Fuzzy guys pretend they don't need any Integral term—they can make just as good a controller for a linear system with 2 knobs as I can with 3—but they're wrong. The Shadow Knows!! More later...

Continuing on the subject of Fuzzy Logic, I must recommend a newsletter[10] from one of the few promoters of F.L. who is a *real engineer*, not just an ivory-tower theoretician. The guy, Dave Brubaker, is thoughtful about solving *real problems* with F.L. I have learned more positive, useful information about F.L. from Dave's newsletter than from everybody else put together. NOT just platitudes. Ask him for a couple samples of his newsletter, and information on how to order it for $24 per year.

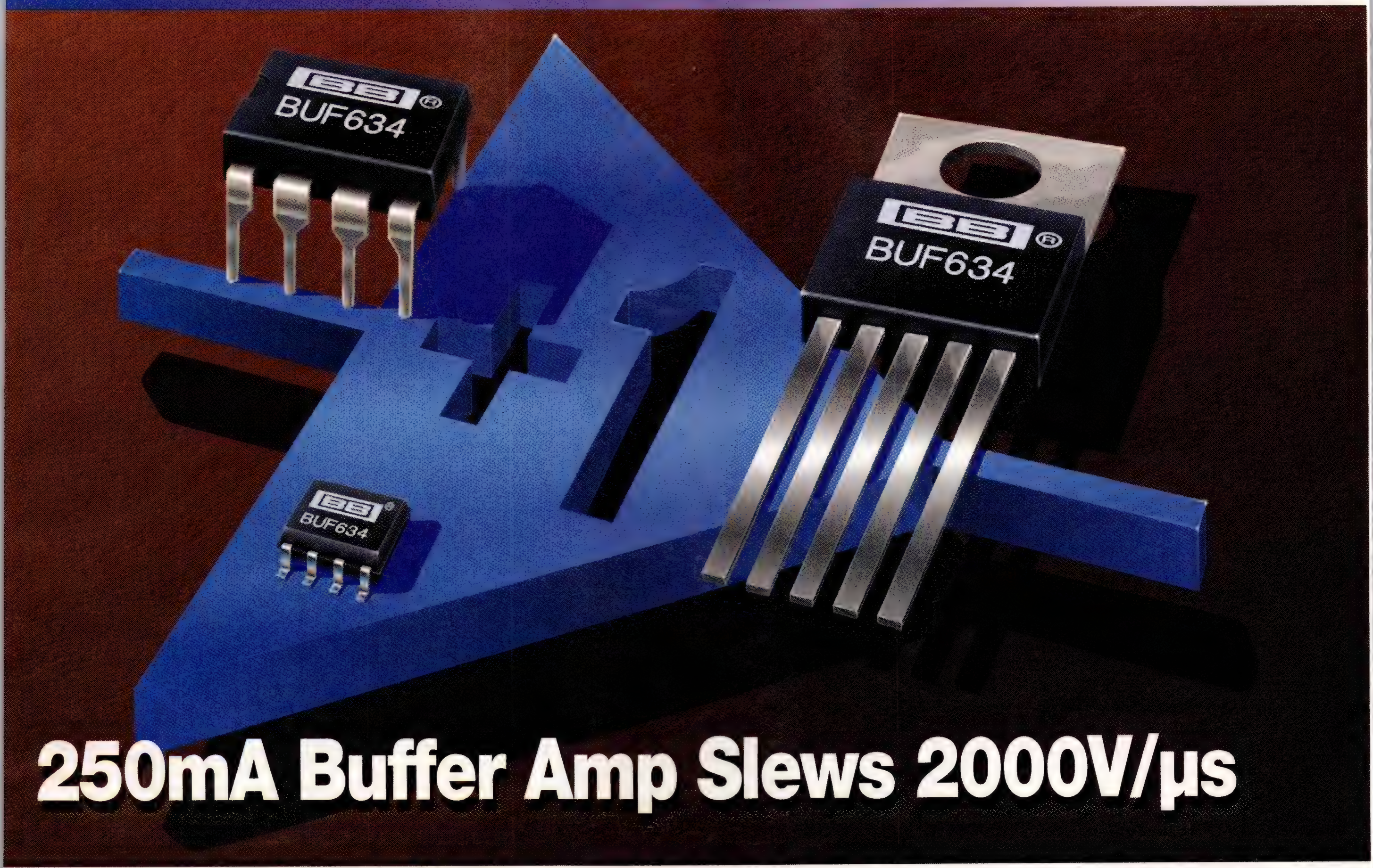
All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

References:

1. Fry's Electronics, 1177 Kern Ave., just off Lawrence Expressway, about 1/3 mile south of U.S. 101, Sunnyvale, Calif. Great assortment of electronic merchandise, from fuses and resistors and ICs up to fancy TV and electronic systems. Also stores in Palo Alto and Fremont. Inquire at 408-733-1770, 415-496-6000, or 510-770-3797.
2. Ambico Inc., 50 Maple St., Norwood, N.J. 07648; phone: 1-800-621-1106.
3. "Better use of dry batteries," Rod Cooper, *Practical Electronics*, July 1986.
4. Ray-O-Vac "Renewal" rechargeable alkaline battery system. Charger costs only $30, nicely built, a real bargain. Special "Renewal" alkaline cells cost 2X more than ordinary alkaline cells; only the Renewal cells can be recharged in the recharger. Available in good department stores or electronics stores. I bought mine in Target.
5. Eveready DA412P zinc-air battery can put out 4.8 V × 6.5 A-hr. That's about as much energy as 4 alkaline C-cells or 2 D-cells, but it weighs only 3.7 ounces, or a factor of 2.7 less. It costs $12 or a factor of 4.5 more than the alkaline cells. You can get this energy only if you draw less than 40 mA for longer than 160 hours. Minimum order is 75 pieces. Zinc-air is great for hearing aids—and for astronauts.
6. *The Audio Critic* magazine: published quarterly, $24 per year, by: Critic Publications Inc., 1380 Masi Rd., Quakertown, PA 18951.
7. Fluke Corp. Model 97, handheld meter and 50-MHz oscilloscope, 4 lb., $1950. Phone: 1-800-44-FLUKE.
8. *Dr. Science's Book of Shocking Domestic Revelations*, ISBN 0-688-11444-X. $17.50 includes shipping. To order, call 1-800-989-DUCK.
9. *Home Power*, published bi-monthly for $15 per year, by Home Power, P.O. Box 520, Ashland, OR 97520.
10. David Brubaker, The Huntington Group, 883 Santa Cruz Ave., Suite 27, Menlo Park, CA 94025-4669.

NEW



250mA Buffer Amp Slews 2000V/μs

Small But Powerful

BUF634 is a high speed, unity-gain buffer amplifier that delivers 250mA output and 2000V/μs slew rate—all in a tiny SO-8 package. Its low price, high performance, and ease of use make BUF634 ideal for a wide range of applications. It's an excellent driver for valves, solenoids, video, and even headphones.

Versatile Yet Simple

BUF634 can be used inside the feedback loop of op amps to increase output current, eliminate thermal feedback, and improve capacitive load drive. Its bandwidth can be pin-programmed for 30MHz with 1.5mA quiescent current or boosted to 180MHz with 15mA quiescent current. BUF634 is the simple solution for all your buffer needs.

Easy And Rugged

BUF634's monolithic design is very rugged—its internal current limit and thermal shutdown protect it from extreme abuse. BUF634 withstands load faults and short-circuits with ease. It's virtually indestructible—you can design-in this device with confidence.

BUF634 Key Specifications

• Output current	250mA
• Slew rate	2000V/μs
• Pin-selected bandwidth	30MHz to 180MHz
• Quiescent current	1.5mA (30MHz BW)
• Supply range	±2.25V to ±18V
• Protection	internal current limit, thermal shut-down

- Packages: 8 pin-DIP and SOIC, TO-220, Dice

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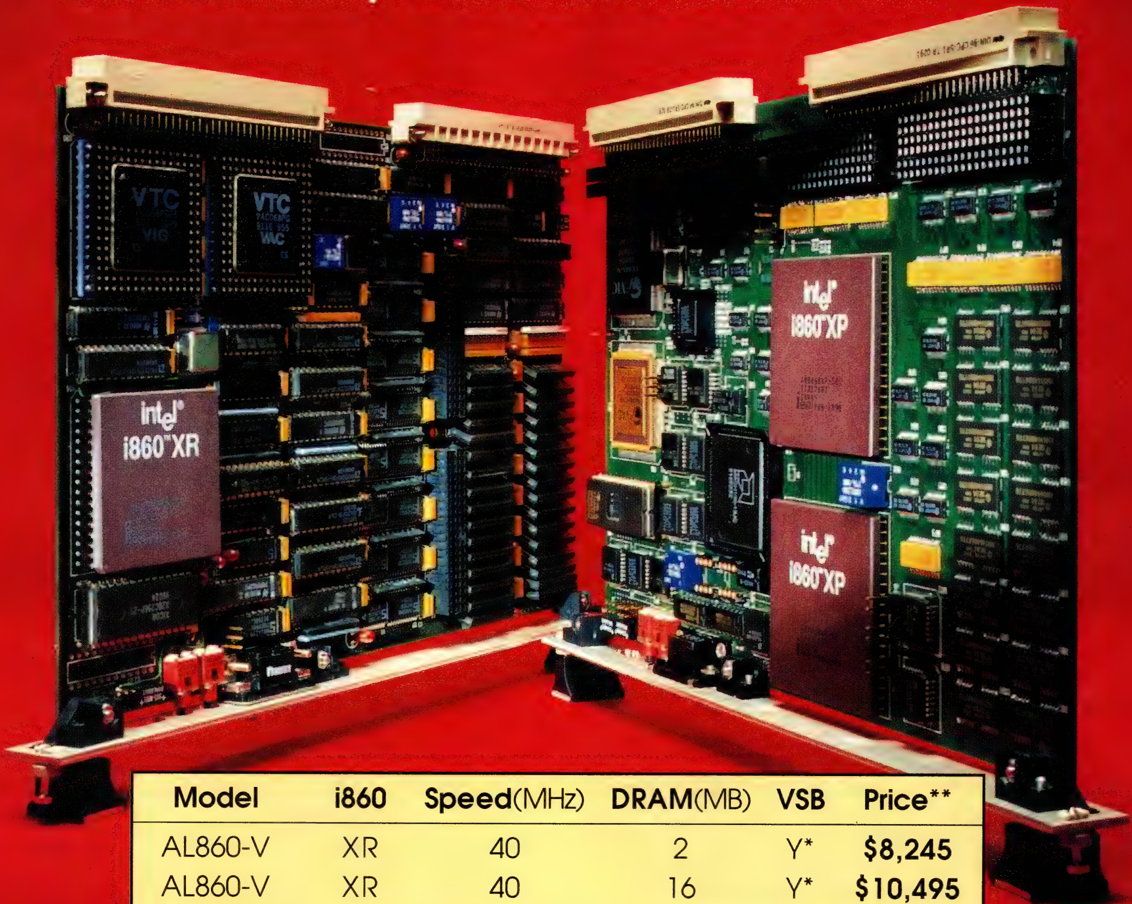

Model	i860	Speed(MHz)	DRAM(MB)	VSB	Price**
AL860-V	XR	40	2	Y*	**$8,245**
AL860-V	XR	40	16	Y*	**$10,495**
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FT*200*/2-V	dualXP	50	16	Y*	**$15,290**

ALACRON i860 VME Beats the Competition Hands Down

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ALACRON

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All product information is accurate as of January 1993. *VSB daughter board option included in price.
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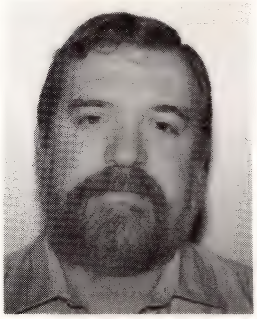
PLUGGING INTO PCMCIA

MANAGING PCMCIA POWER

PAUL STANLEY, SYSTEMSOFT CORP.

What is power management? To some designers, it refers to system-level functions, such as suspend and resume. For others, it applies to sophisticated devices that can operate at different power levels, with varying performance. Either way, there must always be enough power available to activate a particular device or to perform a particular function. But, because the power-management problem has yet to be completely defined, possible solutions are still in the earliest stages.

Power-management software (PMCODE), as developed in a PCMCIA subcommittee, defines an extension to the system BIOS. The PMCODE controls the power consumption of motherboard-resident devices, such as an internal hard-disk drive or an LCD panel. The software maximizes usable battery life for portable systems. Right now, the only way to preserve battery life is by turning devices on and off, depending on when they're needed. Although each PMCODE implementation targets a specific motherboard, there's a commonality of functions among many power-managed products, which means that a base (generic) PMCODE provides a good starting point for designers. Unfortunately, there's little, if any, commonality of design from one PMCODE implementation to another.



The advent of PCMCIA technology makes power management a necessity rather than a luxury. Because users can dynamically swap PCMCIA cards, it's obvious that the PMCODE can't be specific to any one piece of hardware. The seemingly limitless number of PCMCIA cards complicates the prospects of a generic approach to PCMCIA power management. Because the PMCODE resides within the system BIOS, it can't be easily modified in existing machines, which curbs the usefulness of a PMCODE upgrade.

One way to implement PCMCIA-based power-management techniques is by embedding them completely within the PMCODE code. For example, it could reside within the system-management-mode (SMM) code on an Intel SL microprocessor. This solution isolates the power-management activity to a controlled environment and no additional software support is required. However, the disadvantage is that the PMCODE implementations are generally available only from system BIOS suppliers. The subcommittee is considering a proposal to add power-management functionality to the card-information structure (CIS). It would describe the power-management capabilities and requirements of a particular PCMCIA card. The CIS would then contain a generic description of card-specific state information, which must be saved before power is removed from the system and the card.

A second approach places the power management above the PMCODE level in the card's hierarchy. This approach relies upon a PMCODE-aware driver (PMDRVR), such as Microsoft's Advanced Power Management (APM) driver, to communicate the power-management event activity to other high-level software components.

A potentially sophisticated alternative to this approach shares the PCMCIA power-management strategy between the PMCODE and some non-PMCODE software. This solution requires a proprietary interface between the two software layers for synchronization and data exchange. Because the PMCODE software is typically activated preemptively, it may be difficult to supply a reliable communications mechanism between the PMCODE and non-PMCODE software. One proposal defines artificial-removal functions for card services that offer support for basic power-management operations. A second alternative proposes a standardized interface (such as an extension to an existing BIOS function) to supply a partial communications pathway between the PMCODE and the card services.

The proposed solutions, in which card services effectively becomes PMCODE-aware through its interface to the PMDRVR, require a cooperative effort between the card services and the client applications and device drivers. The task of handling the power-management needs of individual cards belongs to the application or device driver using that card.

These unresolved issues must be dealt with before a truly effective power-management strategy for PCMCIA cards can be achieved. The task of reliably saving and restoring the card's state requires software that's both PMCODE- and PCMCIA-aware. Today, this software doesn't entirely exist. PMCODE isn't PCMCIA-aware, card services aren't PMCODE-aware, and applications and device drivers are, for the most part, neither PMCODE- nor PCMCIA-aware.

SYSTEM DESIGN NEWS

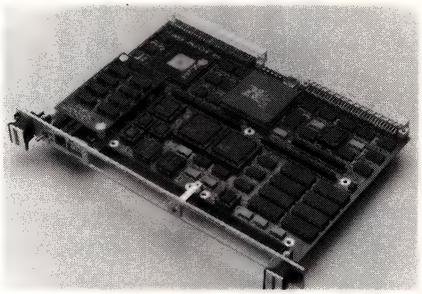
Making a splash into the commercial end of motherboard chip sets, IBM Microelectronics, Hopewell Junction, N.Y., has come up with three 0.8-µm CMOS, 3.3- and 5-V peripheral-component interconnect (PCI) chipset options for designers of x86- or PowerPC-based motherboards. They include the two-chip IBM27-82650 chip set for PowerPC 601-, 603- or 604-based motherboards; the 82454 single-chip bridge for 80486 and BlueLightning (IBM's own 486 derivative) CPUs; and the 82374 PCI-to-ISA (AT-bus) interface chip. The 82650 includes control and datapath support logic and the PCI interface, but requires off-chip support for level-2 cache control. Adding the 82374 creates a three-chip motherboard logic solution that includes ISA bus support. The chip set operates at bus speeds of 25 to 33 MHz, supports a full 64-bit PowerPC memory bus interface, and drives the PowerPC chip at up to 80 MHz. ICs in the 82650 chip set support up to 256 Mbytes of cacheable main memory with parity and come in 160- and 304-lead quad-sided flat packages. The 82374 PCI-to-AT interface comes in a 208-lead QFP and includes 32-bit DMA support for type A, B, or F DMA cycles, and a PCI arbiter for six PCI masters. It can directly drive six ISA card slots, and integrates the interval timers, interrupt controllers, and real-time clock (with 128 bits of low-power RAM). In a 208-lead QFP, the 82454 motherboard/PCI circuit provides PCI and ISA bus interfaces to the x86 processor, controls up to 128 Mbytes of DRAM with parity or error detection and correction (single-bit correct, two-bit detect using a 39-bit word), and incorporates all 82374 support functions. Evaluation boards, manufacturing design kits, and BIOS support are available from IBM. Contact Jerry Frank at (802) 769-6774.

The first phase of a design effort to efficiently produce IC cards that conform to the Personal Computer Memory Card International Association (PCMCIA) standard is now underway. The project, being led by the Microelectronics and Computer Technology Corp. (MCC), Austin, Texas, started with a cost trade-off analysis of circuit-board technology alternatives for advanced PCMCIA applications (including surface-mount, tape-automated bonding, and flip-chip technologies), a worldwide competitive analysis of existing PCMCIA card products, and a benchmark study of supporting electronic packaging processes and suppliers. First-phase participants include Ceridian (Arbitron), Hadco, Harris, Hughes/Delco, IBM, Northern Telecom, and Rockwell International. After this study is finished, MCC expects to embark on an infrastructure and technology development project as defined and directed by member companies. The project's general goals are to develop a PCMCIA design adviser, accelerate commercial availability of cost-effective high-density laminate technology for PCMCIA pc boards, and expedite the commercial availability of flip-chip technology. Call Dennis Herrell at (512) 343-0978.

As part of a licensing deal with Apple Computer Inc. Cupertino, Calif., Dallas-based Texas Instruments Inc. agreed to develop a chip set for use with Apple's just-unveiled FireWire: a P1394-compatible interface. The interface, based on the soon-to-be-approved P1394 serial standard, provides a simple, multi-wire, high-speed serial connection that allows disk drives, scanners, printers, and multimedia devices (video cameras, CD ROMs, etc.) to communicate at 100, 200, and eventually 400 Mbits/s. The proposed IEEE standard employs a six-wire cable consisting of three individually shielded twisted pairs. Two of the pairs carry data and control information, while the third pair serve as power and ground lines. TI will develop chips that incorporate the FireWire technology. The chips will be commercially available as catalog products, with the first products expected in early 1994. Copies of the P1394 draft standard can be ordered from the IEEE Computer Society, 1730 Massachusetts Ave., N.W., Washington, D.C., 20036-1903; phone: (202) 371-0101. Call TI's Bryan Bell at (214) 995-2011 or Apple's Jonathan Zar at (408) 996-1010.

▼ VME BOARD FACILITATES HIGH-SPEED TRANSFERS

Designed for high-throughput VME communications applications, the CVME964 features a i960 RISC processor with 2 or 4 Mbytes of private DRAM, a shared packet memory of up to 32 Mbytes, a mezzanine-bus connector, and a VME64 bus interface. The private DRAM supplies a large memory space with a close link to the processor. The mezzanine connector is an enhanced subset of the i960's data, address, and control signals. Intelligent I/O modules can use DMA to access the shared memory without processor intervention. Even with two modules installed, the board occupies just one VMEbus slot in the backplane. With 2 Mbytes of private memory and 8 Mbytes of shared DRAM, the CVME964 board is priced at $2886 in 100-piece quantities.



Cyclone Microsystems Inc.
25 Science Park
New Haven, CT 06511
(203) 786-5536
▶CIRCLE 620

▼ 0.5-IN. HIGH DRIVE STORES 213 MBYTES

The 1624FCV 0.5-in. (12.7-mm) high disk drive holds 213 Mbytes of data. Built to a 2.5-in. form factor, the drive offers a 13-ms average seek time, an internal data transfer rate of 31 Mbits/s, a 4000-rpm spin rate, and a 128-kbyte segmented cache buffer. Using a two-platter design, the drive weighs just 5.6 oz., consumes an average of 1 W from a single 5-V supply, and spins up to operational speed in 4 seconds. Built with an IDE interface, the MK-1624FCV sells for $425 in large quantities and is available now.

Toshiba America Inc.
9740 Irvine Blvd.
Irvine, CA 92713
(714) 583-3000
▶CIRCLE 621

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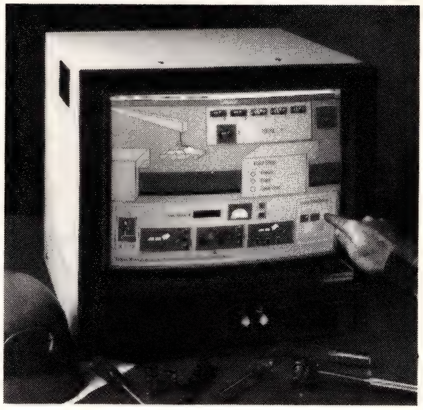
▼ USE TOUCH-SCREEN DISPLAY IN HARSH ENVIRONMENTS

Designed for harsh, industrial environments, the TruePoint DS-20 ruggedized touch monitor combines an analog capacitive touch-screen technology with a 20-in. rack-mount display.



The display is optically bonded for added strength (the sensor is laminated to the CRT), gasket-sealed for water tightness, and has a glass overcoat for scratch and wear protection. It also offers a 0.31-mm dot pitch, a resolution of 1024 by 768 pixels, a vertical scan rate of 45 to 90 Hz, and a horizontal scan rate of 15 to 38 kHz. The DS-20 comes bundled with software drivers for DOS, Windows, and OS/2 to make it easy to add touch capabilities to existing applications. Available now, the touch-screen display system sells for $3245, with large-quantity discounts available.

MicroTouch Systems Inc.
300 Griffin Park
Methuen, MA 01844
(508) 659-9000
▶CIRCLE 622

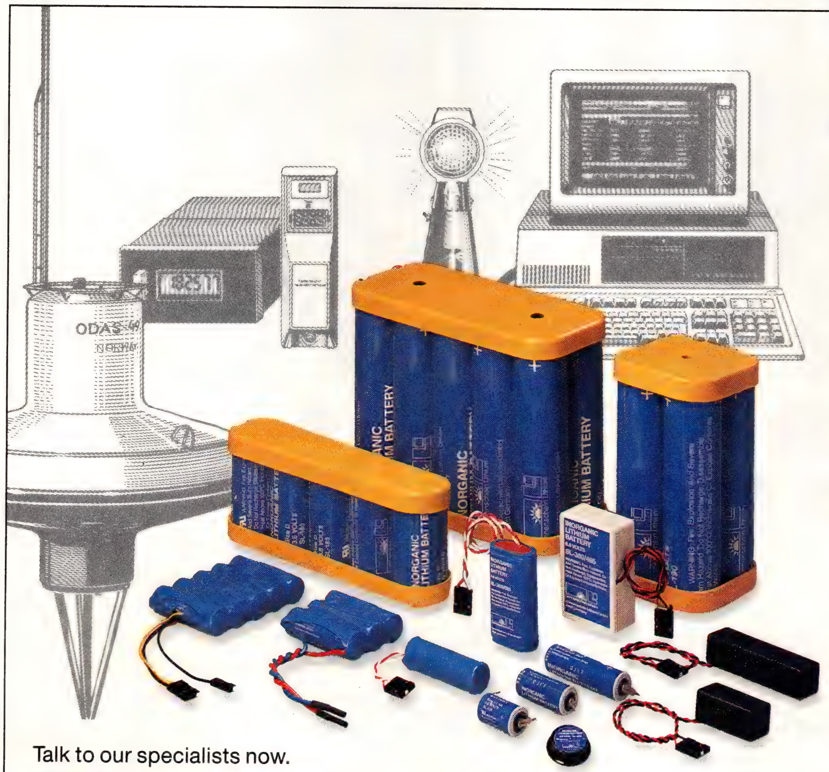
▼ STACK THREE DRIVES IN A 5.25-IN. BAY

The Teac-Stor removable disk drive combines data security with unlimited capacity. The drive simply slips into a bay, and when it's not being used, users can slide the drive out and take it with them. In addition, when the drive reaches its maximum capacity, users just insert a new drive into the bay and file away the filled drive.

The drive comes in three capacities: 250, 360, and 500 Mbytes. Each fits into a slim-line box that measures just 0.5 in. high. Using the appropriate bay, up to three drives can be stacked in a half-height drive bay. Other configurations hold either one or two drives. Using multiple drives in one bay, the drives can be configured to operate as a RAID system.

Complete with an AT interface, the drive is powered by a 5-V source, and it offers a 17-ms seek time and a 19.66-Mbit/s data-transfer rate. The Teac-Stor kit comes with one disk, a docking bay, configuration software, a carrying case, and documentation. The 250-, 360-, and 500-Mbyte drives sell for $500, $600, and $900, respectively. All three models will be available sometime in the first quarter.

Teac America Inc.
7733 Telegraph Rd.
Montebello, CA 90640
(213) 726-0303
▶CIRCLE 623



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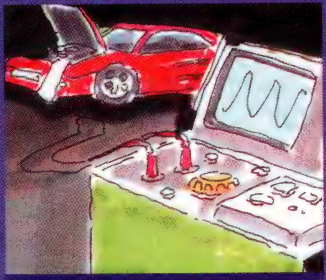

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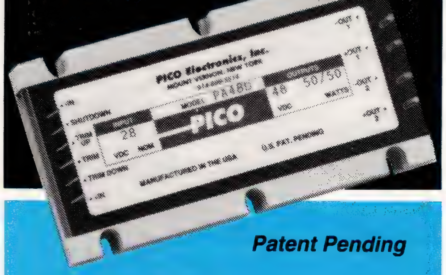

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SYSTEM DESIGN PRODUCTS

▼ 1-IN. HIGH DRIVE STORES 1.05 GYTE

The storage densities of hard-disk drives continue to climb, as is evident with the C3323A drive. In a 3.5-in. form factor, the 1-in. high drive holds 1.05 Gbytes of data and passes data through a SCSI-2 interface with either single-ended, differential, or wide-differential termination. It's designed for multiuser systems, workstations, servers, and disk arrays. The high performance results from a 5400-rpm spin rate. Features include a 9.5-ms average seek time, a 48-Mbit/s maximum burst data rate, and a 512-kbyte on-board cache buffer. Operating power is 8 W. The MTBF specification is rated at 500,000 hours. The C3323A drive is available now for about $1500 in large quantities.

Hewlett-Packard Co.
P.O. Box 58059, MS511L-SJ
Santa Clara, CA 95051
(800) 826-4111
▶ **CIRCLE 624**

▼ ASIC AND SOFTWARE KERNEL ATTACH TO DSP

A DSP architecture, called the SignalMaster, offers a solution to bus-interface problems and enables concurrent operation of multiple DSP-based functions. The architecture consists of an ASIC and a software kernel. The first version of the ASIC connects an AT bus to an Analog Devices 2100-series DSP chip. Later releases will include VL-Bus, PCI, and Micro Channel. The ASIC offers both slave and master capabilities. It also contains trapping logic, which lets the digital signal processor handle accesses by the system sent to registers not implemented in hardware. As a result, the DSP can emulate many card functions, such as audio.

The kernel manages DSP tasks and allocates processing resources in real time. It also performs preemptive multitasking so that multiple DSP algorithms, such as fax/modem, music synthesis, and digital telephony, can operate concurrently. Prices for the SignalMaster solution depend on specific licensing agreements with OEMs.

Aox Inc.
100 Fifth Ave., 7th Floor
Waltham, MA 02154
(617) 684-1400
▶ **CIRCLE 625**

▼ SBC CONNECTS TO COLOR EL DISPLAY

A nine-color electroluminescent (EL) display is built into the Display Pac-Color EL flat-panel computer. The system also contains a 66-MHz 486DX-based single-board computer (SBC) and a capacitive glass touch screen, all packaged in a sturdy 12.6-by-8.6-by-3-in. frame. The board holds up to 32 Mbytes of DRAM, hard- and floppy-disk interfaces, and a mezzanine-bus expansion interface.

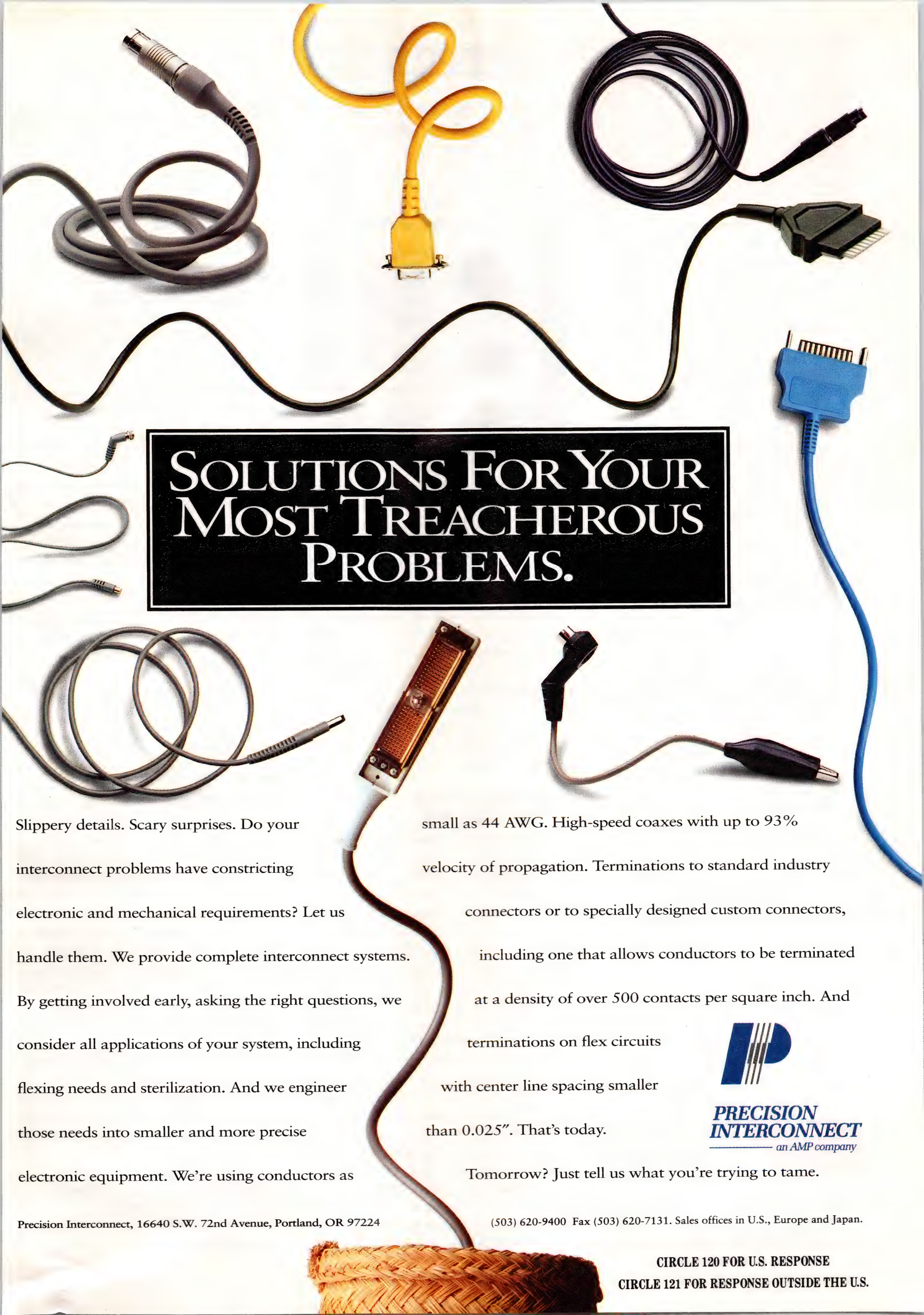
Such applications for the system include medical instrumentation, industrial control, and test and measurement. The display offers a resolution of 640 by 350 pixels, a 160° viewing angle, and an operating temperature of 0 to 55°C. With a 33-MHz CPU, the Display Pac-Color EL sells for $4929 each in lots of 100.

Computer Dynamics Sales
107 S. Main St.
Greer, SC 29650
(803) 877-8700
▶ **CIRCLE 626**

▼ VME BOARD ACCEPTS FOUR PCMCIA CARDS

The RM230 is a VMEbus-based board that accepts up to four PCMCIA memory or I/O cards that are compatible with Release 2.01 of the specification. Its addressable space can accommodate up to 256 Mbytes of memory. The four slots are organized into two blocks, each with a 32-bit data path. An on-board control-status register monitors battery and card usage. Prices for the RM230 start at $580, and it's available now.

RAMix Inc.
9421 Winnetka Ave., Bldg. K
Chatsworth, CA 91311
(818) 349-6772
▶ **CIRCLE 627**



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SYSTEM DESIGN PRODUCTS

▼ 14-IN. DISPLAY FEATURES POWER-DOWN MODES

A power-saving feature has been added to the 1500D 14-in. monitor. As a result, it's compliant with the EPA's Energy Star program. In addition, the monitor features a 76-Hz refresh rate at a 1024- by 768-pixel non-interlaced resolution and microprocessor-based digital controls.

The monitor has four power states: On, standby, suspend, and off. In standby, the power consumption drops by 20%. In suspend, it consumes less than 30 W, and in the off state, it pulls in less than 5 W. Compatible with most popular standards, the 1500D is available now for $419.

Optiquest Inc.
20490 E. Business Pkwy.
Walnut, CA 91789
(800) 853-6784
▶ **CIRCLE 628**

▼ ATTACH SCSI TO PCI LOCAL BUS

Developing SCSI-based PCI motherboards may be become easier using the PCSCSI single-chip fast SCSI-2 controller. The part resides on a motherboard to supply a glueless interface to the PCI local bus. PCI is a 32-bit local bus that eliminates the traditional I/O bottleneck between the CPU and high-performance peripherals, such as graphics controllers. With the SCSI controller, up to seven peripherals (such as disk, tape, and CD-ROM drives) can be connected internally or externally. The PCSCSI contains a PCI bus-interface unit, a bus-master DMA engine, and a fast SCSI core. Operating-system support includes MS-DOS, Windows 3.1, Windows NT, OS/2, Unix, and Netware. A SCSI BIOS can be integrated by system vendors or used as an expansion ROM. Samples of the PCSCSI are available now. In 1000-piece quantities, the part costs $24.95.

AMD Inc.
901 Thompson Pl.
P.O. Box 3453
Sunnyvale, CA 94088
(408) 732-2400
▶ **CIRCLE 629**

▼ TINY BOARD HANDLES ALL PC FUNCTIONS

In a space that measures 3.1 by 4 in. (the form factor of a 2.5-in. disk drive), the PCIB contains all of the functionality of a complete PC while consuming just 3 W. The embedded board is built with an AM386-SXL 25- or 33-MHz microprocessor. It supports from 2 to 16 Mbytes of main memory and comes with an on-board IDE disk-drive controller, two RS-232 serial ports, a parallel port, and a battery-backed real-time clock. Up to 512 kbytes of flash memory are available for application use. A developer's platform includes cables and connectors for testing and a hardware bench stand that adds interfaces for serial and parallel ports and three ISA-bus card slots.

AGI Inc.
23 Richmond St.
Rochester, NY 14607
(716) 377-8480
▶ **CIRCLE 630**

▼ PC-COMPATIBLE CLOCK KEEPS PRECISE TIME

The NTR1000-P is a PC-based real-time clock card that's accurate to within ±5 seconds per month. The board is suited for applications that require precise timing, such as control, test, and measurement. It's referenced to a stable crystal with a known aging rate. To further increase accuracy, the oscillator is calibrated to the PC's normal operating temperature, although accuracy is maintained over a 0 to 50°C temperature range. Also, the board is compatible with Novell networks. By installing the card in the file server, it can be accessed by any node on the network. The NTR1000-P, with software and documentation, is priced at $199 and is available now.

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10180 Scripps Ranch Blvd.
San Diego, CA 92131
(800) 523-2320
▶ **CIRCLE 631**

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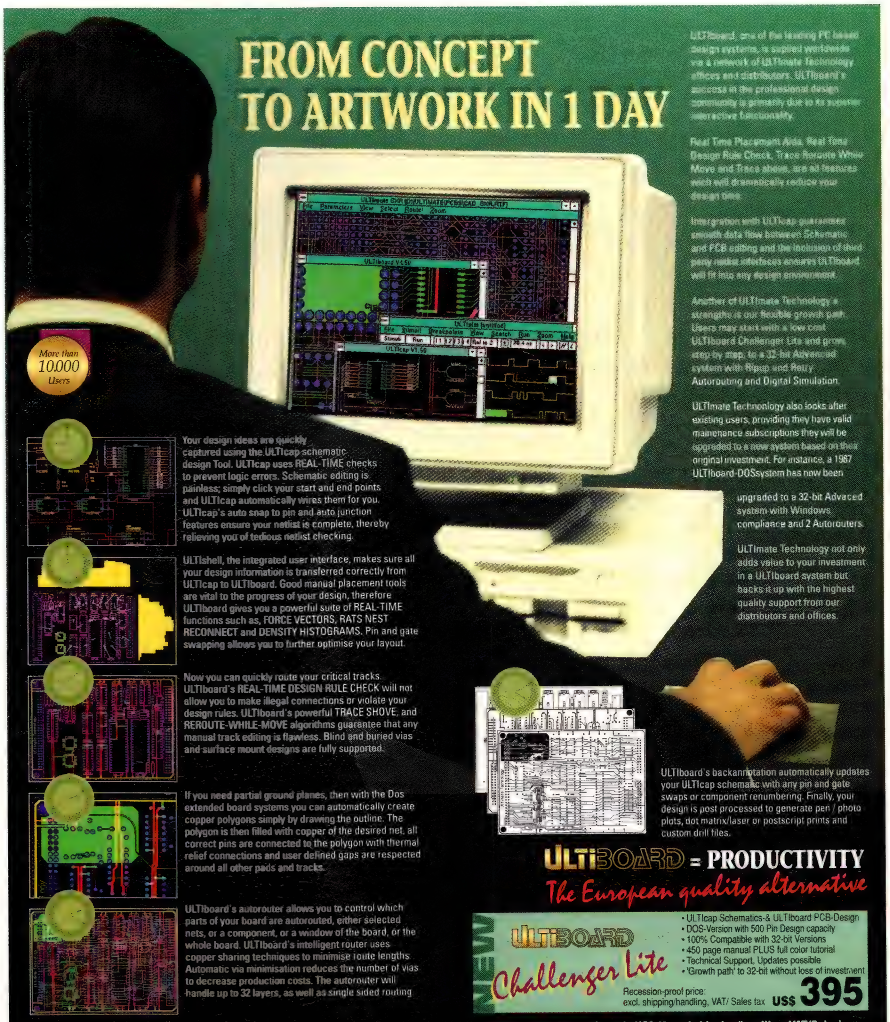

ULTIboard, one of the leading PC based design systems, is suplied worldwide via a network of ULTImate Technology offices and distributors. ULTIboard's success in the professional design community is primarily due to its superior interactive functionality.

Real Time Placement Aids, Real Time Design Rule Check, Trace Reroute While Move and Trace shove, are all features wich will dramatically reduce your design time.

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Another of ULTImate Technology's strengths is our flexible growth path. Users may start with a low cost ULTIboard Challenger Lite and grow, step by step, to a 32-bit Advanced system with Ripup and Retry Autorouting and Digital Simulation.

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ULTImate Technology not only adds value to your investment in a ULTIboard system but backs it up with the highest quality support from our distributors and offices.

Your design ideas are quickly captured using the ULTIcap schematic design Tool. ULTIcap uses REAL-TIME checks to prevent logic errors. Schematic editing is painless; simply click your start and end points and ULTIcap automatically wires them for you. ULTIcap's auto snap to pin and auto junction features ensure your netlist is complete, thereby relieving you of tedious netlist checking.

ULTIshell, the integrated user interface, makes sure all your design information is transferred correctly from ULTIcap to ULTIboard. Good manual placement tools are vital to the progress of your design, therefore ULTIboard gives you a powerful suite of REAL-TIME functions such as, FORCE VECTORS, RATS NEST RECONNECT and DENSITY HISTOGRAMS. Pin and gate swapping allows you to further optimise your layout.

Now you can quickly route your critical tracks. ULTIboard's REAL-TIME DESIGN RULE CHECK will not allow you to make illegal connections or violate your design rules. ULTIboard's powerful TRACE SHOVE, and REROUTE-WHILE-MOVE algorithms guarantee that any manual track editing is flawless. Blind and buried vias and surface mount designs are fully supported.

If you need partial ground planes, then with the Dos extended board systems you can automatically create copper polygons simply by drawing the outline. The polygon is then filled with copper of the desired net, all correct pins are connected to the polygon with thermal relief connections and user defined gaps are respected around all other pads and tracks.

ULTIboard's autorouter allows you to control which parts of your board are autorouted, either selected nets, or a component, or a window of the board, or the whole board. ULTIboard's intelligent router uses copper sharing techniques to minimise route lengths. Automatic via minimisation reduces the number of vias to decrease production costs. The autorouter will handle up to 32 layers, as well as single sided routing.

ULTIboard's backannotation automatically updates your ULTIcap schematic with any pin and gate swaps or component renumbering. Finally, your design is post processed to generate pen / photo plots, dot matrix/laser or postscript prints and custom drill files.

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CIRCLE 225 FOR U.S. RESPONSE

CIRCLE 226 FOR RESPONSE OUTSIDE THE U.S.

▼ QIC TAPE DRIVE STORES 13 GBYTES

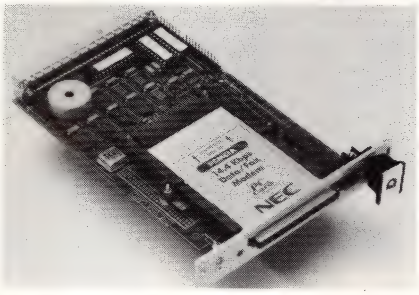
As the capacities of hard-disk drives and disk arrays grow, the storage densities of quarter-inch-cartridge (QIC) tape drives increase as well. For example, the TDC 6100 boasts a native capacity of 13 Gbytes and a data rate of 1.5 Mbytes/s in a half-height 5.25-in. form factor. In addition, the drive is read- and write-compatible with all QIC recording formats.

With an OEM-quantity price of under $995, the 6100 dramatically lowers the cost per megabyte. Also, the drive features an MTBF of 300,000 hours. The specs result from a new generation of ICs, enabling the use of a dual-channel head, which in turn increases the number of tracks on the tape to 144 for data and 24 for servo positioning.

Tandberg Data Inc.
2649 Townsgate Rd., Suite 600
Westlake Village, CA 91361
(805) 495-8384
▶ CIRCLE 632

▼ CONNECT PCMCIA CARDS TO VMEBUS SYSTEMS

The DMEM20 low-power 3U VMEbus board connects PCMCIA cards into VMEbus systems. Compatible with Release 2.0 of the PCMCIA standard, board can handle Type 1, 2, or 3 cards. Through jumper selection, the DMEM20 can be configured to occupy any 8-kbyte address range in the VMEbus 64-kbyte I/O address space. In large quantities, prices for the DMEM20 start at $466.



Dynatem Inc.
23455 Madero, Suite B
Mission Viejo, CA 92691
(714) 855-3235
▶ CIRCLE 633

▼ DIGITAL AUDIO BOARD EMPLOYS DOLBY CODING

The Series 2 Model SX-22 digital audio board can handle compressed professional broadcast-quality stereo sound through a PC using Dolby AC-2 coding. The board, based on a TI TMS320C31 DSP chip, employs the Dolby AC-2 bit-rate reduction technique for compressed sound at three sample rates—32, 44.1, and 48 kHz. Specialized I/O permits direct digital connection to professional and consumer digital-audio equipment, and can transmit the sound over a network without sacrificing quality. With a built-in EEPROM-based security scheme, developers and system integrators are able to give each audio board a unique ID. As a result, application developers can instruct their code to look for the board. The SX-22 costs $2295.

Antex Electronics Corp.
16100 South Figueroa St.
Gardena, CA 90248
(310) 532-3092
▶ CIRCLE 634

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The National Arbor Day Foundation

The competition is behind our 12-bit ADC all the way.

1MHz 12-bit ADCs				
DEVICE	**National ADC12062 Monolithic**	Analog Devices AD1671 Monolithic	Crystal CS5412 Monolithic	Datel ADS-112 Hybrid
Power Dissipation	**75mW max**	750mW max	1W max	1.7W max
Gain Error	**±1LSB max**	±10LSB max	±8LSB max	±8LSB max
Offset Error	**±1.25LSB max**	±8LSB max	±3LSB max	±5LSB max
Integral Non-Linearity	**±1LSB max**	±2LSB max	±1LSB max	±1.5LSB max
Signal-to-Noise Ratio (f_{in} = 100KHz)	**69.5dB min**	69dB min*	68dB min	68dB min

*SINAD, no SNR spec available.
All specs over extended temperature range. Suggested resale 1K pc pricing starts at $29.35 for the ADC12062 and $33.70 for the ADC12662.

When you compare the power, precision and value of 1MHz 12-bit ADCs, our ADC12062 comes out ahead every time.

In fact, the only one that comes close is our own 1.5MHz ADC12662, which uses just 200mW (max). Both guarantee unmatched AC and DC specs and operate at +5V. Both have a two-channel MUX and sample/hold. And both are available with evaluation boards.

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IC AMP/MIXER CONVERTS 900 MHZ RF TO 100 MHZ IF

A LOW-NOISE AMPLIFIER/MIXER CIRCUIT AND DUPLEXER CONNECT A TRANSCEIVER'S ANTENNA AND IF STAGE DIRECTLY.

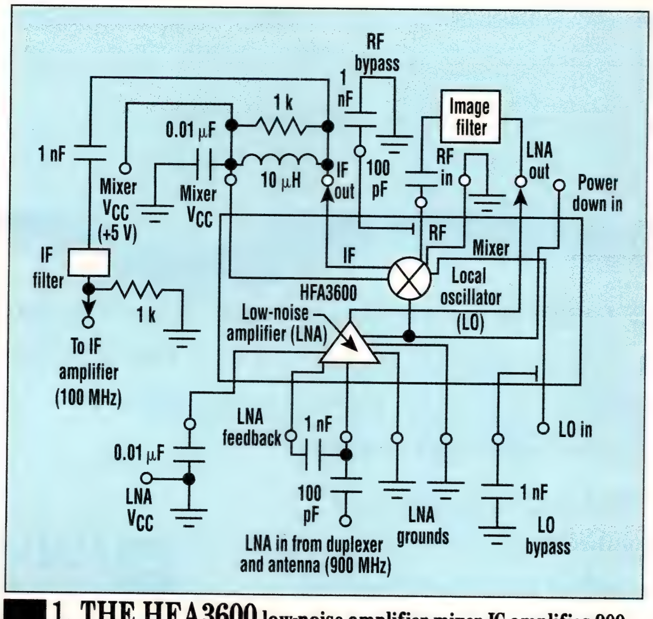
FRANK GOODENOUGH

The portable and wireless phenomenon continues to infiltrate all facets of the electronics world. However, the equipment involved with this wave of technology, such as cellular and cordless telephones, calls for increasingly higher performance combined with diminishing size, power, and cost. To meet these demands, Harris Semiconductor's designers have come up with a tiny IC in a 14-pin SOIC. Dubbed the HFA3600, it combines on the same chip a low-noise RF amplifier with a single balanced mixer.

The mixer down-converts a 900-MHz RF signal to 100 MHz, which is then ready to feed to an IF amplifier. To create a transceiver front end, usually a designer only needs to add a duplexer between the HFA3600 amplifier/mixer IC and the antenna *(Fig. 1)*.

In both the U. S. and Europe, 900 MHz is the nominal standard frequency for cellular and cordless telephones. The device will work in U. S. IS-54 systems that span 800-990 MHz, and in European systems that adhere to the Groupe Speciale Mobile (GSM) standard and operate at 900 MHz and 1.8 GHz. The HFA3600 amplifier/mixer IC will also work on CT-1 and CT-2 types of cordless telephones.

At 900 MHz, the power gain of the HFA3600's low-noise amplifier (LNA) alone typically runs 11 dB, its noise figure is just 2.4 dB, and the third-order intercept point is +10.7 dBm (referred to the output). By itself, the mixer circuit has an 8.1-dB power gain, a noise figure of 6.7 dB, and a +13.1-dBm third-order intercept point (again, referred to the output). Combined together, the complete LNA and mixer system exhibit 19.1 dB of power gain, a 3.1-dB noise figure, and a third-order intercept point of –7-dBm (this time, referred to



1. THE HFA3600 low-noise amplifier-mixer IC amplifies 900-MHz signals from an antenna. The mixer down-converts it to a 100-MHz signal that's ready for an IF amplifier.

the input).

Noise figure, in decibels, is the ratio of the signal-to-noise ratio (SNR) at the output of a "system" to the SNR at its input. It thus indicates how much noise the "system" adds. The third-order intercept point represents a function of the distortion introduced by amplifier nonlinearity, while power gain defines the magnitude of the circuit's power amplification.

Taken together, these three characteristics of an RF circuit define its dynamic range, indicate its ability to process low-level signals (based on gain and noise figure), and show how well it can deal with some forms of interference (based on gain and third-order intercept point).

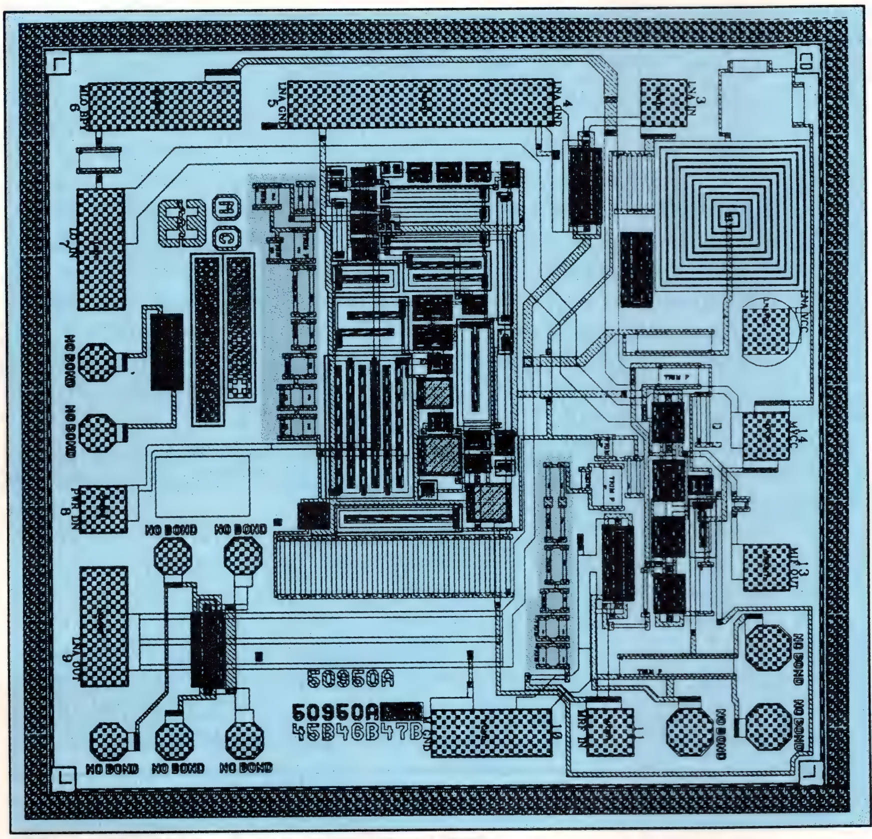
Because there's no functionally similar competitive device, according to Harris Semiconductor, the HFA3600 is best compared with a similar device in a system complete with a duplexer, LNA, image filter, mixer, IF filter, and IF amplifier. Used in such a complete receiver front end, the typical cascaded gain for the HFA3600 runs 25 dB, noise figure runs 7.26 dB, and the third-order intercept point (referred to the input) is –2 dBm. The same specifications for a receiver built with a competitive device run 19.4 dB, 8.97 dB, and –8.8 dBm, respectively.

POWER DOWN

A growing group of non-digital ICs, including the HFA3600, are borrowing a feature long found on digital ICs: The ability to power down to extend battery life in portable systems. While the HFA3600 uses less than 13 mA from a 5-V rail, when it's put to sleep by an external logic signal, quiescent current drops to just 250 μA. The mixer section of the competitive device can be powered down, but it still draws 4 mA of current from the power-supply rail.

The HFA3600 is fabricated on Harris' UHF-1 bonded-wafer complementary bipolar process, which provides vertical npn transistors with an f_t of 8 GHz and vertical pnp transistors with an f_t of 5.5 GHz. Unlike the discrete technology that's replaced by the UHF-1 process, this new process can also be used to build spiral inductors for RF circuits, such as the one shown in the upper right-hand corner of the HFA3600 die *(Fig. 2)*. It ensures that the LNA is unconditionally stable. The inductor gives the LNA low gain at low frequencies and high gain at high frequencies.

At the bottom of the figure, three parallel horizontal lines carry the LNA's output to a bonding pad on the left. The use of three rather than one trace reduces inductance, which helps maintain signal integrity. A vertical line of small rectangles stretching from the center of the die to the top consists of trimmable thin-film resistors for setting transistor biases. These will indirectly determine ac performance. A second set of trimmable resistors below and to the right of the die's center set the mixer's gain.



2. THE SPIRAL INDUCTOR IN THE upper right-hand corner of this low-noise amplifier/down-converter IC ensures that the amplifier is unconditionally stable. Three parallel horizontal lines (lower left) carry the amplifier's output to a bonding pad. The highlighted areas represent trimmable thin-film resistors for setting the amplifier's bias (upper left) and the mixer's gain (lower right).

SIMPLER DESIGNS

ICs that combine the functions of the amplifier and mixer are relatively new at 900 MHz. As long as UHF receiver front ends were built with discrete transistors, their design required empirical know-how and a substantial investment in circuit breadboarding and test time to guarantee optimum performance.

However, using ICs like the HFA3600 can eliminate much of that effort. Harris Semiconductor does include detailed application schematics, recommended pc-board artwork, S parameters, noise-figure data, third-order intercept characterization data, as well as evaluation boards for the HFA3600.□

PRICE AND AVAILABILITY

The HFA3600 operates over the extended-industrial-temperature range. It comes in a 14-pin SOIC. In quantities of 1000, it goes for $3.56 each.

Harris Semiconductor, P.O. Box 883, Melbourne, FL 32901; 1-(800)-4-Harris, ext. 7137. **CIRCLE 512**

HOW VALUABLE?	CIRCLE
HIGHLY	550
MODERATELY	551
SLIGHTLY	552

PRODUCTS NEWSLETTER

PROGRAMMABLE SWITCHES ROUTE SYSTEM SIGNALS

Taking advantage of its in-system programmable electrically erasable technology, Lattice Semiconductor Corp., Hillsboro, Ore., developed a family of in-system programmable "switch matrices" that allow circuit designers to build flexible systems. Inside the matrices are two banks of I/O lines, designated "A" and "B". Any I/O line in bank A can be connected to any I/O line in bank B, or vice versa, with an input-to-output delay of just 7.5 ns. In addition, each I/O line can be set to a fixed TTL High or Low logic level (DIP switch equivalent function). Matrix sizes implemented in the EECMOS process include a 7-by-7, 9-by-9, and an 11-by-11 matrix, and are programmed over the company's four-wire ISP serial interface. With the programmable switch matrix, designers can reprogram the signal routing on a pc board, similarly to the RAM-based programmable interconnect chips from Aptix allow signals to be rerouted. The smaller pin count of the Lattice ispGDS (in-system programmable generic digital switches)—20 to 28 pins—versus the 1024 pins of the Aptix matrix, suits the Lattice circuits to simple systems that might need only a few signals rerouted for applications such as clock routing or DIP-switch settings. Contact Stan Kopec, (503) 681-0118. *DB*

CIRCLE 900

REDUCED-NOISE PLDs EASE SYSTEM DESIGN

By reducing the output edge rates on its 10- and 15-ns GAL programmable logic chips, National Semiconductor Corp., Santa Clara, Calif., reduced the ground bounce on the 16V8 and 20V8 by as much as 50% when contrasted with comparable devices from other manufacturers. The lower noise suits the electrically reprogrammable devices well for high-end computing and telecommunications systems, which cannot tolerate noise induced errors. The 20-pin GAL16V8QS and the 24-pin GAL20V8QS are the first members of the company's Quiet Series of GALs, a family optimized for low ground bounce with a specified and guaranteed low-noise level and short setup times. In lots of 100 units, the 10- and 15-ns versions of the 16V8 sell for $2.50 and $1.25 each respectively; the same speed grades for the 20V8 sell for $4.50 and $1.60, respectively. Contact John Bergen, (408) 721-2990. *DB*

CIRCLE 901

SPEEDY 16-BIT-WIDE PROM ACCESSES IN JUST 25 NS

Based on a 0.8-μm CMOS process, the CY7C276 EPROM in a PROM pinout accesses in just 25 ns. As a result, it provides the short access times needed by DSP chips and other high-speed processors. The PROM from Cypress Semiconductor Corp., San Jose, Calif., is organized as 16 kwords by 16 bits and matches the word-wide buses of the 16-bit DSP chips. The memory chip includes three polarity-programmable chip-select lines and a polarity-programmable output-enable line, so it provides on-chip decode logic for eight memory banks without requiring external components. Available in windowed packages, the CY7C276 can be erased and then reprogrammed using Cypress's QuickPro II or other commercially available programmers. Production quantities of the 44-lead PLCC or LCC-housed PROM are immediately available with access times of 35, 30, or 25 ns. In lots of 100 units, prices range from $21.80 each for the 35-ns PLCC version to $37.10 each for the 25-ns LCC version. Call Cypress at (408) 943-2600. *DB*

CIRCLE 902

REMOVABLE CARTRIDGE FITS PCMCIA DRIVE

What must users typically do when their $300 PCMCIA Type-3 hard drive is filled to capacity? If they had a SyQuest SQ1080 drive, they could simply stick in a new 80-Mbyte cartridge that costs about $40. The SQ1080 is actually a drive housing, similar to the 3.5-in. drives offered by SyQuest, Fremont, Calif. The difference is that the housing fits the PCMCIA Type-3 standard. Hence, it's suited for portable systems. Another use for the drive is in embedded applications, such as cameras, where the disk media would replace the film. The company says that the 80-Mbyte disk has ample memory to store 50 digital images. In addition to the drive's low-power rating, 1.6 W in read-write mode and 0.15 W in sleep mode, it is very durable. The MTBF is 150,000 hrs. and it can absorb a non-operating shock of 225 Gs and a 100-G operating shock. Samples of the SQ1080 are now shipping. Production should start in the first quarter of next year. For more information, contact SyQuest at (800) 245-2278 or (510) 226-4000. *RN*

CIRCLE 903

Edited by Clifford Meth

"Turn on the TV or radio—open a newspaper or magazine—and odds are you'll find an ad for a Procter & Gamble product.

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"Why do we invest so much in advertising? Because it works!"

Edwin L. Artzt, Chairman and CEO, The Procter & Gamble Company

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I believe when you start with products like ours—products that make people's lives better—people are loyal to them because of the positive brand character great advertising creates.

And it's our long-term commitment to advertising that's helped put our brands in 97% of all American households.

Sure, all of us would like to think what we make is so superior that one use, one taste, one washing, one box, and zap—we have a loyal user for life.

If it were only that simple. Fact is, people need to want to try your product. They need to have their beliefs challenged. And that's where advertising's words and images—and ideas—rise to the occasion.

In the end, no consumer-driven company can hope to remain a leader without a deep-seated commitment to advertising, for one undeniable, irrefutable reason:

It works."

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If you would like to learn more about the power of advertising, please write to Department D, AAAA, 666 Third Avenue, New York, NY 10017, enclosing a check for five dollars. You will receive our booklet, *It Works! How Investment Spending in Advertising Pays Off.* Please allow 4 to 6 weeks for delivery. This advertisement prepared by D'Arcy Masius Benton & Bowles, Inc.

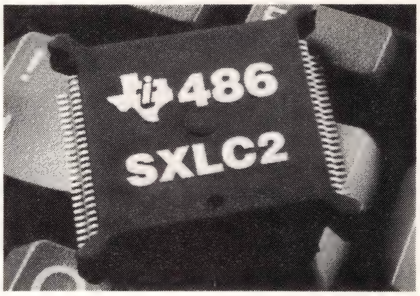
LOW-POWER 486 CPUS CONSERVE BOARD REAL ESTATE

Speeds up to 50 MHz can be obtained from a small footprint 486SX-compatible microprocessor from Texas Instruments. Designed to operate at 3.3 V, the 486SXLC2 is earmarked for subnotebook and handheld computers. The chip features clock doubling, an 8-kbyte internal cache, and advanced power-management capabilities.

Also from TI is the 486SXL2 processor, which has similar features to the SXLC2, yet it supports a 32-bit chipset, while the SXLC2 supports 16 bits. Both devices can run at 50 MHz internally (25 MHz externally) when powered to 5 V. At 3.3 V, they run at 40 MHz internally. Other members are also available in both families.

A dynamic clock-scaling feature on the 486SXL2 supplies only the power that's required to run an application. For example, a compute-intensive application requires more CPU interaction. As a result, the processor would run at full speed. But in a less compute-intensive application, such as a word processor, less power would be needed to run the processor, which lowers the system's overall power consumption.

Another difference between the two TI processors is the packages. The 486SXL2 is housed in a 168-pin ceramic PGA. The 486SXLC2 fits in 100-pin quad flat pack (QFP), which occupies 47% less board space than Intel's 486SX 208-pin QFP. This part fits the footprint of a 486SLC processor, while the 486SXL2 fits the 486SX footprint.



Prices for the two families range from $79 to $149, depending on speeds and quantity ordered. Samples of all the different versions are available now. Production will start in January.

Texas Instruments Inc., *Semiconductor Group, SC-93076, P.O. BOX 172228, Denver, CO 80217; (800) 477-8924, ext. 3726.* **CIRCLE 670**

■ *RICHARD NASS*

AN ALTERNATIVE 486 MICROPROCESSOR PACKS MORE FEATURES, DRAWS LESS POWER

Although it can drop into the same socket as the Intel 80486DX or DX2, the Cyrix Cx486DX and Cx486DX2 microprocessors include more on-chip features with better or comparable overall throughput.

Cyrix combined its efficient math coprocessor with the 486-compatible core that it developed. In addition, the company also added 8 kbytes of four-way set-associative cache to create a work-alike central processing unit that can drop right into existing 80486-based systems. Moreover, if the systems are Cyrix-aware (the motherboard chip set knows that the cache also operates in a write-back mode), then plugging in the Cyrix chip will enhance overall system performance.

The Cx486 core also contains a 16-bit integer multiplier, as does the 386 core that was previously developed by the company. That multiplier transparently helps central-processing-unit throughput when handling various graphics operations and some limited digital-signal-processing operations.

In most cases, floating-point computations are faster than the floating-point math performed by Intel's 80486, thanks to a more efficient embedded floating-point unit. In the integer mode, though, not every Cx486 instruction executes faster than instructions on Intel's equivalent-speed 486. Consequently, depending on the specific benchmark, the i486 might come out a little ahead, but Cyrix expects its Cx486 will run just a little faster in most cases. The differences in execution times are caused by the separately developed on-chip microcode used to interpret each instruction.

Some power-saving features were also transparently added to the Cx486 microprocessors—the on-chip floating-point unit has an automatic power-down mode that saves about 500 mW, dropping the operating current from about 775 mA for Intel's 486DX to about 680 mA for the Cx486 CPUs.

Furthermore, the CPUs have an on-the-fly stop-clock capability that allows the CPU clock to be started and stopped on a moment's notice. The clock circuitry uses a patent-pending clock-delay scheme and does not employ a phase-locked loop, thus avoiding the instability period each time a PLL is turned on or off. As a result of this, the system can implement a simple power-management scheme that just turns off the clock whenever the system is idling. This considerably trims back power.

The Cx486DX family will come in non-clock-doubled versions that operate internally and externally at 33, 40, or 50 MHz, and clock-doubled versions that operate at 40 or 50 MHz, internally, and 25 or 20 MHz, externally. However, unlike the Intel CPUs which reduce the internal clock speed to the bus frequency during external reads or writes, the Cyrix CPUs can maintain the doubled internal clock speed.

In lots of 1000 units, all versions that operate at a frequency of 40 MHz or less (internally), including a 3.3-V 33-MHz unit, sell for $289 apiece; the 50-MHz versions sell for $349 each in the same quantity. Samples of the microprocessor are available from stock.

Cyrix Corp., *2703 N. Central Expressway, Richardson, TX 75080; Jim Chapman, (214) 994-8387.* **CIRCLE 671**

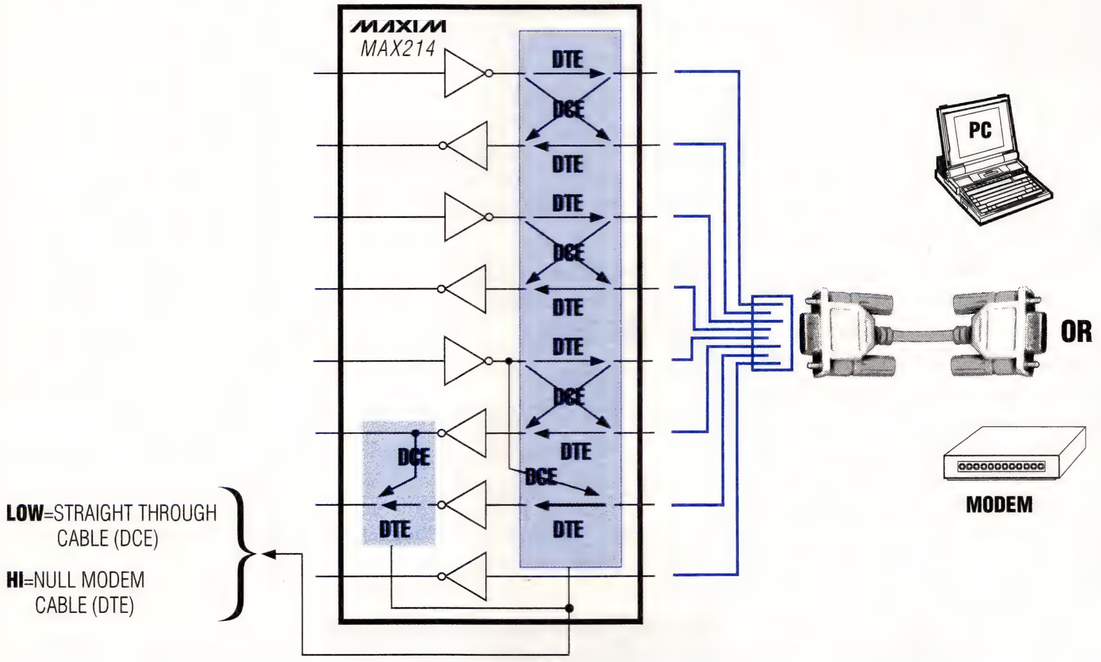
■ *DAVE BURSKY*

RS-232 IC ELIMINATES MULTIPLE CABLES AND MAKES NULL MODEMS OBSOLETE

One IC connects directly with both DTE and DCE ports!

Maxim's new MAX214 changes from a DTE port to a DCE port with the flick of a switch, eliminating the need for null modem cables. The +5V powered MAX214 meets EIA/TIA-232 specifications, is guaranteed to run at data rates up to 120kbps, and has a low power shutdown mode that reduces supply current to 20μA.

MAX214's INTERNAL SWITCHES ADAPT TO ANY RS-232 CABLE OR PORT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MAXIM

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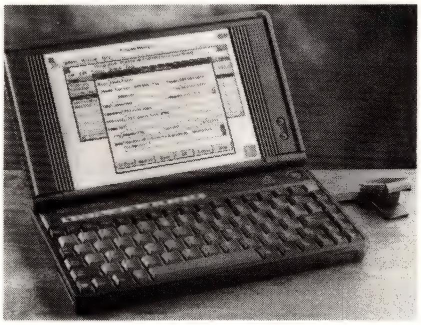
CIRCLE 161 FOR U.S. RESPONSE CIRCLE 162 FOR RESPONSE OUTSIDE THE U.S.

386-BASED PC WEIGHS 2.9 LBS.

The OmniBook 300 portable PC measures just 11.1 by 6.4 by 1.4 in. and weighs just 2.9 lbs. The 386-based system runs on four AA batteries and features an enhanced reflective display and either a rotating hard-disk drive or flash-based memory. It has four built-in PCMCIA slots—one is used for the mass-storage device and one is used by a ROM card that holds Microsoft Windows, Word, and Excel. Two slots remain for PCMCIA-based peripherals, such as LAN card, modems, memory cards, etc. A built-in modem is available as an option. Also, data can be transferred through an infra-red link between two compatible systems. The OmniBook is built with an intuitive pointing device, a pop-up mouse that hides within the system when it's not in use. With a 40-Mbyte drive, the OmniBook sells for $1950. A 10-Mbyte flash card pushes the price to $2375. RN



Hewlett-Packard Co., 1000 N.E. Circle Blvd., Corvallis, OR 97330; (800) 443-1254. **CIRCLE 672**

RAID ENSURES FAULT TOLERANCE

High-speed, fault-tolerant computing can be obtained from the 7135 RAIDiant disk array. The array supports mission-critical applications on clusters of RISC System/6000 PowerServers that run IBM's AIX software. Any combination of RAID 0, 1, 3, or 5 can be simultaneously implemented. The array includes 2.6 Gbytes of disk storage, which can be expanded to 60 Gbytes. It supplies such features as concurrent maintenance of drives, controllers, power supplies, and cooling devices, as well as the ability to hot swap drives. Redundant cooling and power supplies are standard components. Three configurations are available, including a single controller, a standby controller, or dual-active controllers. The standby and dual-active controllers supply automatic takeover if an error is detected. RN

IBM Corp., 1133 Westchester Ave., White Plains, NY 10604. **CIRCLE 673**

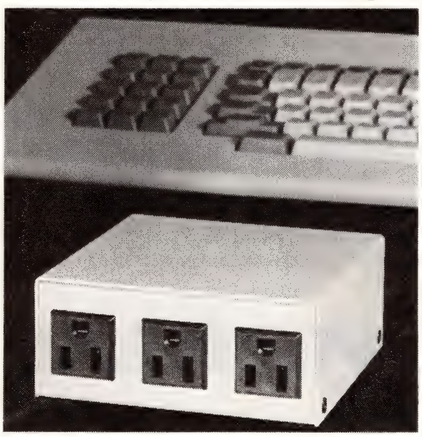
DISK ARRAY FITS DEC ENVIRONMENT

Built for the DEC-workstation environment, the StingRay 210 high-performance SCSI disk array offers a performance of 110 I/Os per second on each drive. This comes from a rotational rate of 7200 rpm, an average latency of 4.17 ms, and an average access time 12.17 ms. Each drive offers a capacity of 2.1 Gbytes in a 3.5-in. form factor. Up to four drives can be installed in a half-size enclosure, while seven drives fit in the full-size enclosure. Other configurations are offered. Prices for the StingRay 210 start at $6740. The drives are available now. RN

MTI, 4905 E. La Palma Ave., Anaheim, CA 92807; (714) 970-0300. **CIRCLE 674**

DEVICE CUTS PC POWER BY 75%

The EnergySaver, which connects to a computer, keyboard, and a standard ac outlet, can reduce a system's energy consumption by 75%, say its designers. The device monitors keyboard activity, and shuts off the peripherals after a user-selectable delay. The peripherals include such things as a monitor, printer, modem, scanner, and so on. Typing on the keyboard automatically brings the peripherals back to life. The EnergySaver also automatically turns the peripherals off when the system is powered down. For safety, the device contains opto-couplers to isolate the computer from the wall outlet. A built-in circuit breaker adds protection for the peripherals. No software installation is required. The EnergySaver costs $149. OEM discounts are available. RN



Artek Innovations, 5824 Tan Oak Dr., Fremont, CA 94555; (510) 795-0333. **CIRCLE 675**

TEXT TERMINAL HANDLES 30 OPERATING SYSTEMS

The Dorio text terminal is a low-cost, single-session platform for open systems. It offers 16 terminal emulations, keyboard support for up to 25 country languages, and compatibility with more than 30 operating systems, including DOS, Unix, and VMS. The terminal comes with serial and parallel ports, a mini-DIN (PS/2-compatible) keyboard connector, an easy-to-read display, and a cartridge slot for firmware enhancements. Also, all keys are remappable to eight levels. Available now, the Dorio text terminal sells for $399. RN

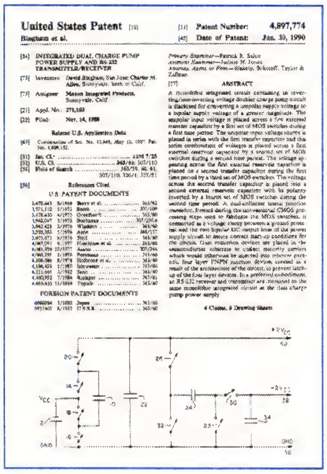
Digital Equipment Corp., Maynard, MA 01754; (800) BY-DORIO. **CIRCLE 676**

SRAM CARDS BOAST 125-NS ACCESS TIMES

A family of PCMCIA-based SRAM cards lowers the access times to 120 ns. Three versions of the Type 2 cards are available: the KMCJ616256, KMCJ616512, and KMCJ616000, which store 512 kbytes, 1 Mbyte, and 2 Mbytes, respectively. Each card comes with a replaceable lithium main battery and an on-board rechargeable auxiliary battery, which maintains the card's charge should the main battery fail. The cards operate from a single 5-V supply, require from 0.3 to 0.5 mA in standby mode, and from 10 to 34 μA when the card is removed from the host. All three cards are available now. The 512-kbyte, 1-Mbyte, and 2-Mbyte cards sell for $125, $200, and $275, respectively, in quantities of 100. RN

Samsung Semiconductor Inc., 3655 North First St., San Jose, CA 95134; (800) 446-2760 or (408) 954-7000. **CIRCLE 677**

DID YOU KNOW MAXIM OWNS THE BASIC PATENTS ON ALL +5V RS-232 INTERFACE ICs?



United States Patent [19]
Bingham et al.

[11] Patent Number: 4,897,774
[45] Date of Patent: Jan. 30, 1990

[54] INTEGRATED DUAL CHARGE PUMP POWER SUPPLY AND RS-232 TRANSMITTER/RECEIVER

[75] Inventors: David Bingham, San Jose; Charles M. Allen, Sunnyvale, both of Calif.

[73] Assignee: Maxim Integrated Products, Sunnyvale, Calif.

[21] Appl. No.: 271,160

[22] Filed: Nov. 14, 1988

[57] ABSTRACT

4 Claims, 8 Drawing Sheets

Maxim holds 6 U.S. patents covering fundamental principles of +3V- and +5V-powered RS-232 circuits, whether the IC is CMOS, BiCMOS, or Bipolar.

Maxim invented +5V-powered RS-232 circuits in 1984, and Maxim offers 41 different part types today – the widest selection in the industry!

TRUE RS-232 FROM A +5V SUPPLY.

Introducing the MAX232 +5V RS-232 dual transmitter-receiver.

Choose Maxim's Patented* RS-232 IC For Your Design

Part Number	Power Supply (V)	Drivers/ Receivers	Caps (µF)	Shutdown & 3-state	Receivers Active in Shutdown	Data Rate (kbits/sec)
MAX211	5	4/5	0.1	✓		120
MAX213	5	4/5	0.1	✓	2	120
MAX223	5	4/5	1.0	✓	2	120
MAX241	5	4/5	1.0	✓		120
MAX560	3	4/5	1.0	✓	2	120
MAX561	3	4/5	1.0	✓		120

INTERFACE
ANALOG DESIGN GUIDE
Data Sheets • Application Notes • Free Samples
+3V Receivers Stay Active in Shutdown
Throw Away Your Expensive 1488s, 75175s, 145406s ...
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*Patent numbers: 4,636,930; 4,679,134; 4,777,577; 4,797,899; 4,809,152; 4,847,522; 4,897,774; 4,999,761. Purchase of products covered by these patents from anyone other than Maxim or a Maxim authorized licensee is an infringement of Maxim's rights.

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CIRCLE 163 FOR U.S. RESPONSE **CIRCLE 164 FOR RESPONSE OUTSIDE THE U.S.**

SOFTWARE TOOL ACCELERATES BOUNDARY-SCAN TEST DEVELOPMENT

Reductions in ASIC development and board-level testing costs are made possible by Automatic JTAG Builder, a software tool based on the IEEE-1149.1 Boundary Scan standard, also known as the Joint Test Action Group (JTAG) standard. The software performs boundary-scan and Test Access Port (TAP) controller insertion, test generation for boundary-scan logic, and automatic creation of Boundary-Scan Description Language (BSDL).

Automatic JTAG Builder accepts the original netlist of system logic in NDL, Verilog, or VHDL format. The final netlist also uses these standards. Test vectors delivering over 95% fault coverage are automatically generated for the JTAG-related logic in the ASIC. To minimize the number of test pins, the tool lets ASIC designers share the scan-in/scan-out pins among boundary and internal scan chains. The ability to output BSDL, which is a subset of VHDL tailored to 1149.1, is important because it enables automatic test pattern generation at the board level. In combination, these capabilities ensure a designer-transparent solution.

With Automatic JTAG Builder, designers can use LSI Logic's boundary-scan cells and TAP controller synthesis or they can use their own implementations. The software can also employ the JTAG cells within LSI Logic's ASIC library, which includes a built-in multiplexer in the I/O cells to maximize system performance by reducing delays in the functional path.

The software supports IEEE-1149.1's optional instructions—like High Z, Clamp, Intest, Cncatenate, and Runbist— as well as mandatory instructions like Bypass, Sample/Preload, and Extest. Both user tools and ATPG tools can benefit from these instructions.

Automatic JTAG Builder is offered as a service to customers of LSI Logic's Design Centers for $10,000 to $12,000. Customers can purchase their own copy for $12,000.

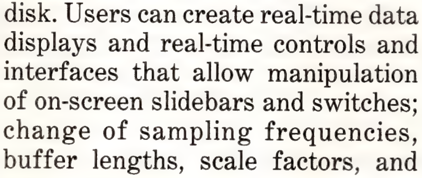
***LSI Logic Corp.,** 1551 McCarthy Blvd., Milpitas, CA 95035; (408) 433-8000.* **CIRCLE 699**

■ *JOHN NOVELLINO*

GRAPHICAL SOFTWARE CREATES DATA AQUISITION PROGRAMS

Visual Designer is a Windows-based graphical application generator for PC-based data acquisition, test, measurement, and control. The software allows users to create a custom Windows application without programming.

Applications are constructed by connecting a set of icons into a block diagram. These icons represent function blocks for analog and digital I/O capability, graphic displays, waveform generators, measurement and comparison functions, math and logic operations, and other functions that normally would require hundreds of lines of code each.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Visual Designer supports dynamic data exchange, so users can export data to other Windows programs. It also allows high-speed data streaming to disk and data playback from disk. Users can create real-time data displays and real-time controls and interfaces that allow manipulation of on-screen slidebars and switches; change of sampling frequencies, buffer lengths, scale factors, and alarm setpoints; and control of on-off switches.

The software works with all PCI-20000 series data acquisition boards and accessories and supports hardware speeds up to 1 MHz. It runs on IBM-compatible 386DX- and 486-based PCs with at least 4 Mbytes of RAM, 10 Mbytes of hard disk space, and VGA graphics. An 8-Mbyte RAM is highly recommended and is required for applications using direct memory access.

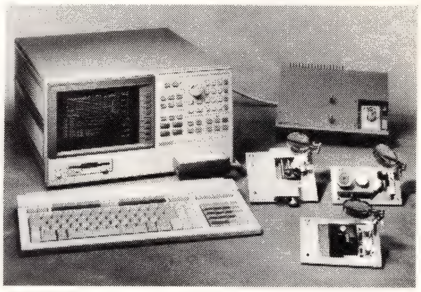
In the US, Visual Designer's introductory price is $495 until January 1, 1994. The price includes one year of free software enhancements. After that date, the list price is $995.

***Intelligent Instrumentation,** 6550 S. Bay Colony Dr., MS 130, Tucson, AZ 85706; (800) 685-9911.* **CIRCLE 700**

■ *JOHN NOVELLINO*

IMPEDANCE ANALYZER HANDLES SMDS TO 1.8 GHZ

The HP 4291A impedance/material analyzer for surface-mount devices and its family of integrated test fixtures measure impedances from 0.1 Ω to 50 kΩ at frequencies to 1.8 GHz. The fixtures handle devices from 0.5 to 20 mm long. Each fixture comes with an attached magnifying glass for easy device insertion. Calibration and compensation routines for the fixtures are built into the analyzer. Traditionally, RF impedance is derived from a reflection measurement. But the HP 4291A measures impedance as a one-port lumped element from a ratio of voltage and current, providing a direct measurement for non-50-Ω devices. The HP 4291A costs $37,000. Fixtures range from $1760 to $2200. Estimated delivery time is four weeks. JN



Hewlett-Packard Co., Direct Marketing Organization, P.O. Box 58059, MS51L-SJ, Santa Clara, CA 95051-8059; (800) 452-4844.

CIRCLE 701

WORLD'S GREATEST POWER SUPPLY ICs FOR NOTEBOOK COMPUTERS

Maxim's industry-leading MAX782/MAX786 dual-output 3.3V & 5V notebook power supplies provide:

◆ **Longest Battery Life:**
  - **95% efficiency at high load current; 85% at 10mA**
  - **70µA $I_{STANDBY}$ for static RAM or real-time clock**

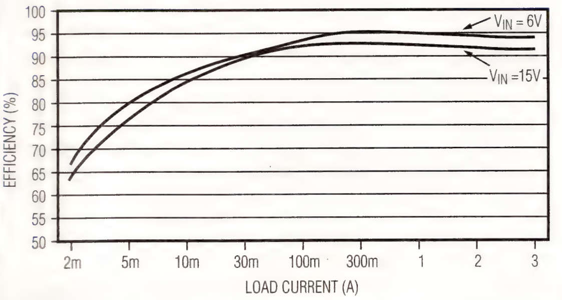
◆ **Smallest Size:**
  - **25cm^2 area, 5mm height (complete circuit)**
  - **30µF/A filter capacitors; 10µH inductors**
  - **300kHz master oscillator**

◆ **Most Complete Solution:**
  - **Replaces 6 or more ICs**
  - **Dual PWM, 3.3V and 5V buck regulators**
  - **Dual PCMCIA V_{PP} outputs (MAX782)**
  - **Precision voltage monitors**

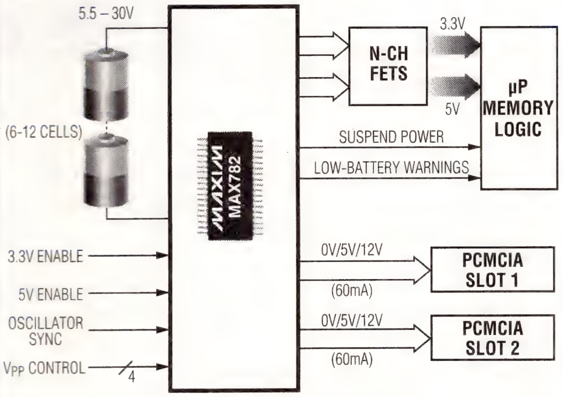
◆ **Lowest Noise and EMI:**
  - **Excellent transient response**
  - **Fixed-frequency for noise-sensitive RF-wireless systems**

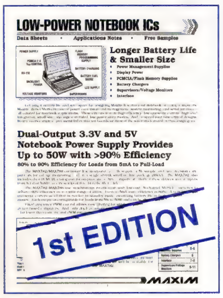
For quick evaluation, order a pre-assembled demo board (order MAX782EVKIT-SO, or MAX786EVKIT-SO). MAX782 is $5.95*, and the MAX786 is $4.15*.

MAX782 5V OUTPUT



MAX782 SYSTEM BLOCK DIAGRAM




LOW-POWER NOTEBOOK ICs

Data Sheets • Applications Notes • Free Samples

Longer Battery Life & Smaller Size
- Power Management Supplies
- Display Power
- PCMCIA/Flash Memory Supplies
- Battery Chargers
- Supervisors/Voltage Monitors
- Interface

Dual-Output 3.3V and 5V Notebook Power Supply Provides Up to 50W with >90% Efficiency

80% to 90% Efficiency for Loads from 5mA to Full-Load

1st EDITION

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Includes: Data Sheets and Cards for Free Samples

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* 1000 PC, FOB USA, suggested resale.

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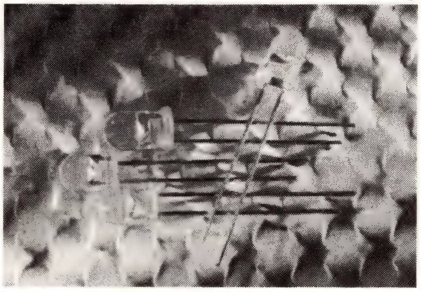
CIRCLE 165 FOR U.S. RESPONSE　　**CIRCLE 166 FOR RESPONSE OUTSIDE THE U.S.**

INFRARED LEDS OFFER HIGH OUTPUT



An exceptionally high output of 15 mW/sr, while matching the peak sensitivity exhibited by current silicon photodiodes, is offered by a line of infrared LEDs. The SIR-481 STS diodes also offer excellent matching characteristics, enabling them to be incorporated in a wide range of applications requiring infrared emissions. Typical uses include computer touch screens, remote controls, and other consumer and industrial uses. Peak wavelength is 940 nm and viewing angle is 50°. Forward voltage is 1.4 V typical and 1.6 V maximum with a maximum forward current of 50 mA. Pricing is \$0.20 in lots of 10,000. Delivery is in eight weeks. DM

ROHM Electronics Div., 3034 Owen Dr., Antioch, TN 37013; Mike Halvorson, (615) 641-2020. **CIRCLE 678**

HIGHLY STABLE TCXO NEEDS NO WARM-UP

Two families of temperature-compensating crystal oscillators (TCXOs) are offered for use in products requiring affordable, stable frequencies over wide temperature ranges, such as communications, navigation, and test equipment. The devices' internal components are so precisely matched that there is no need for a warm-up period after power is applied. Operation is to specification immediately upon powering the units. One family offers two standard sizes: the RTXO-046 measures 1.5 in.^{2} by 0.5 in. tall. The RTXO-100 is half that size. The other family, the RTVO-046 and -100, offers the same sizes but adds a voltage input for automatic ±3-ppm aging adjustments. Both families feature stability-versus-load specifications of ±0.5 ppm or better for zero-to-10-fanout loads. Stability versus time is specified at ±1 ppm/year or better. In lots of 1000, pricing ranges from \$20 to \$235. Delivery is in four weeks for prototypes and in eight to 12 weeks for volume orders. DM

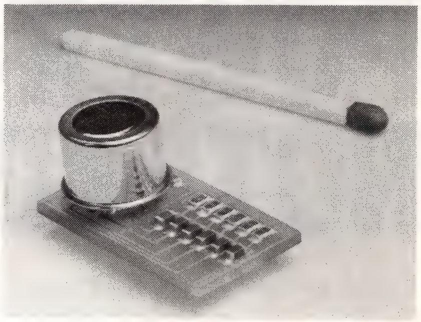
Raltron Electronics Corp., 2315 N.W. 107th Ave., Miami, FL 33172; (305) 593-6033. **CIRCLE 679**

LOW-COST EL LAMPS ARE SCREEN-PRINTED

A screen-printing process for producing electroluminescent (EL) lamps yields products with the high brightness and long life associated with EL technology but at about half the cost of competing products. The NovaLite series is built entirely on a screen-printing table with no hand assembly. They offer extreme thinness (as low as 12 mils), superior flexibility, and the ability to be built in virtually any shape. Power consumption is as low as 10 mA with a matched inverter circuit, and the lamps generate no heat. They're also solid state, so there's little possibility of catastrophic failure. Pricing in volume quantities is as low as \$0.25 per square inch. Call for delivery information. DM

ELtech, 181 Gibraltar Rd., Horsham, PA 19044; Brad Lizotte, (215) 441-0404. **CIRCLE 680**

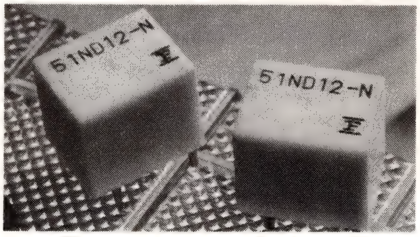
PHOTOMULTIPLIER TUBE COMES IN TO-8 CAN



A photomultiplier tube (PMT) that's housed in a TO-8 metal can offers the performance of much larger PMTs, enabling these light-sensitive devices to fit into applications that have been the exclusive domain of semiconductors. The OPTO-8 PMT offers significant advantages compared to both larger PMTs and avalanche photodiodes (APDs), and is the first PMT that can be mounted on pc boards. The OPTO-8 PMT requires just 800 V dc for operation compared with over 2000 V for large-area APDs and delivers higher performance for a given active area. The unit's total length is 10 mm. Other specifications include a dark current of 1 nA and a noise figure of 1.4 dB. Samples are available now and standard configurations will be available in 60 days from receipt of order. Small-quantity pricing ranges from \$320 to \$340. DM

Hamamatsu Corp., 360 Foothill Rd., Box 6910, Bridgewater, NJ 08807-0910; David Leinwand, (908) 231-0960. **CIRCLE 681**

SMALL PCB RELAY CARRIES HIGH CURRENT



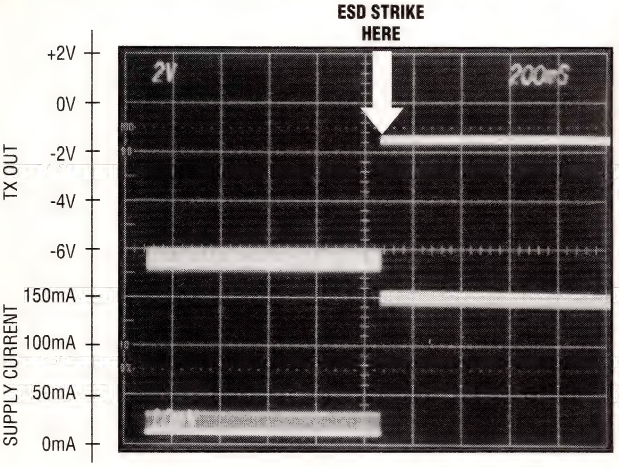
A miniature, 20-A-class power relay for automotive applications is designed to provide improved performance under overload conditions. The FBR50 Series relay takes up just 0.30 in.^{2} of pc-board space while offering a maximum carrying current of 25 A. The series is suitable not only for automotive accessories but also for any applications requiring high-current switching and small size. The series comprises two lines, the FBR51 and FBR52. Although both have 20-A make and 25-A carry current ratings, the FBR52 unit's wider, 0.6-mm contact gap results in higher ratings for the breaking current. The FBR51 is recommended for breaking loads up to 12 to 15 A, and the FBR52 breaks loads up to 30 A. Pricing in lots of 1000 is \$1.20 and \$1.28 for the FBR51 and FBR52, respectively. Delivery is from stock. DM

Fujitsu Microelectronics Inc., Electronic Components Div., 3545 N. First St., San Jose, CA 95134; (800) 642-7616. **CIRCLE 682**

TRUE ±10kV ESD PROTECTION FROM A CMOS +5V RS-232 IC!

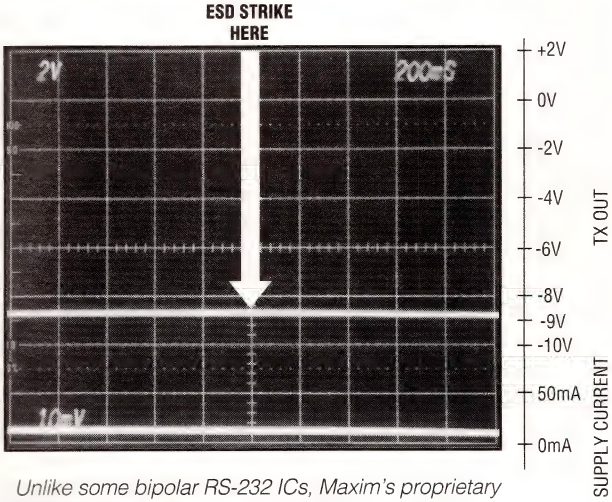
Designed for harsh environments, Maxim's ruggedized MAX211E, MAX213E, and MAX241E are the industry's first RS-232 transceivers to provide true ±10kV ESD protection per the Human Body Model on all RS-232 I/O pins. And, unlike some bipolar solutions, Maxim's CMOS MAX211E, MAX213E, and MAX241E are immune to latch up!

TYPICAL BIPOLAR LATCHED BY -2kV TO -10kV ESD



Bipolar Charge Pump Output can collapse, and supply current can increase to 150mA when the receiver input is zapped with -2kV to -10kV, latching the device.

MAXIM CMOS SURVIVES ±10kV ESD



Unlike some bipolar RS-232 ICs, Maxim's proprietary CMOS ESD structure protects RS-232 I/O pins from ±10kV ESD without latching up.

Select a Maxim Latch Up Free, ±10kV ESD, RS-232 IC

Part	TX/RX	ESD**	Caps µF	Latch Up Free	Data Rate kbps	RX Active	Icc (Shutdown)	Price†
MAX211E	4/5	±10kV	0.1	Yes	120		1µA	$3.62
MAX213E	4/5	±10kV	0.1	Yes	120	2	15µA	$3.62
MAX241E	4/5	±10kV	1.0	Yes	120		1µA	$3.62

**ESD testing done on all RX in and TX out pins using Human Body Model waveform detailed in Mil Standard 883 method 3015.7
†1000 up, suggested resale FOB USA.

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CIRCLE 167 FOR U.S. RESPONSE

CIRCLE 168 FOR RESPONSE OUTSIDE THE U.S.

SPARC-BASED VME BOARDS BOAST EXPANDABILITY

Three Sparc-based VME boards from Force Computers Inc. offer high performance and expandability. The CPU-3CE is built with the 40-MHz Texas Instruments microSparc processor and is compatible with Sun's SparcClassic workstation. It's suitable for industrial and office-automation applications.

The microSparc chip integrates integer and floating-point units with the MMU, and also contains instruction and data caches, and an SBus interface. The 6U form factor CPU-3CE can hold up to 64 Mbytes of DRAM. Other features include ports for fast SCSI, Ethernet, and serial I/O. Available now, the board sells for $2995 with 8 Mbytes of memory.

The CPU-10 and CPU-10/9U are similar, but have different form factors. The CPU-10 is built with a SuperSparc processor, which has a 20-kbyte instruction cache and a 16-kbyte data cache. Using secondary-cache modules, the memory can be increased to 1 Mbyte. Maximum system memory is 128 Mbytes. The board has room for two SBus modules for customization. As a result, it takes up three VME slots in a backplane (two slots when no SBus boards are used). The CPU-10, available at the end of the year, will cost $11,995 with 32 Mbytes of memory.

The CPU-10/9U houses two 40-MHz SuperSparc CPUs in a 9U form factor. Maximum system memory is 512 Mbytes, which can grow to 1 Gbyte using an expansion module. The processors are connected using standard MBus modules. Four SBus slots supply the expandability. One of the slots can be used for designs that take advantage of the P2 connector user I/O pins. An SBus VME subsystem bus (VSB) adapter will be available shortly. Shipping now, the CPU-10/9U costs $12,995 with 32 Mbytes.

Force Computers, *2001 Logic Dr., San Jose, CA 95124; (408) 371-5900.* **CIRCLE 683**

■ *RICHARD NASS*

TINY BOARD HOLDS FOUR DSPS

As digital-signal processing becomes a popular way to perform multimedia, speech recognition, teleconferencing, and data compression, one board that can handle those tasks is the DON module, which packs four AT&T DSP3210 floating-point digital-signal processors and 64 Mbytes of DRAM in 3 by 3.3 by 0.75 in. The DON module, which pumps out 133 MFLOPS, offers a 32-bit nonmultiplexed data and address bus and four 25-Mbit/s serial ports with independent DMA.

The DON modules could show up anywhere from a PC motherboard to high-end VMEbus CPU boards. Up to four modules fit onto an ISA- or EISA-based board. On a motherboard, the module would be mounted directly as a mezzanine card through a slim-line connector. In addition to saving space, this configuration simplifies the signal routing.

Each processor is tied together through a common 32-bit local bus that runs at speeds up to 45 Mbytes/s. An on-board arbiter manages the shared memory and the external data and address bus. The 32-bit bus supports full bus mastering and can be used for either memory expansion or for accessing external I/O peripherals.

The modules run AT&T's Visible Caching operating system (VCOS), a multimedia OS that's suited for multiprocessing. The host-resident portion of VCOS schedules and loads multiple tasks onto multiple DSP chips. The four-processor board is available now for under $1000 in large quantities.

Ariel Corp., *433 River Rd., Highland Park, NJ 08904; (908) 249-2900.* **CIRCLE 684**

■ *RICHARD NASS*

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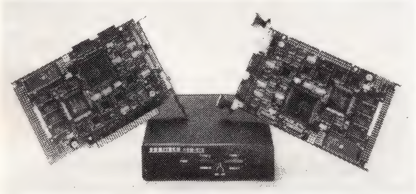
CIRCLE 122 FOR U.S. RESPONSE
CIRCLE 123 FOR RESPONSE OUTSIDE THE U.S.

DSP BOARD DOUBLES AS PROTOCOL CONVERTER

Designed for either protocol conversion with a TI digital-signal processor or stand-alone digital-signal processing, the ASM-C/S board can handle PC, VME, or busless applications. In addition to the 8 kbytes of memory internal to the resident 320C31 processor, the card holds up to 256 kbytes of zero-wait-state (25-ns) SRAM for embedded applications. The board's flexibility lets users upgrade from a C30-based system to a C40 system without changing any serial-based I/O devices. The board's serial interface can handle up to 8 Mbits/s. The PC/XT version sells for $495, the 3U VME card costs $595, and the standalone board is priced at $695. The latter comes with a rack-mountable box and an external power supply. All three models are available now. RN



Sonitech International Inc., 14 Mica Lane, Wellesley, MA 02181; (617) 235-6824. **CIRCLE 685**

PARALLEL DSPS SIT ON ISA BUS

PCs can take advantage of parallel-processing techniques using the Fig board, a scalable plug-in card. The board supplies nine Analog Devices ADSP 2105 processors and is designed so that multiple boards can operate in parallel. Applications for this setup include compute-intensive arithmetic calculations, logic operations, and data comparisons. The complete package includes the board, parallel-processing application libraries, a DOS device driver, and a C compiler. Eight of the nine processors are used by application programs, while the remaining processor, used as an interface device, manages the communications between the other processors and the ISA bus. The Fig package is available now for $2800. RN

Squid Solutions Inc., 738 Main St., 397, Waltham, MA 02154; (617) 647-5696. **CIRCLE 686**

486-BASED SBC FITS IN ONE VME SLOT

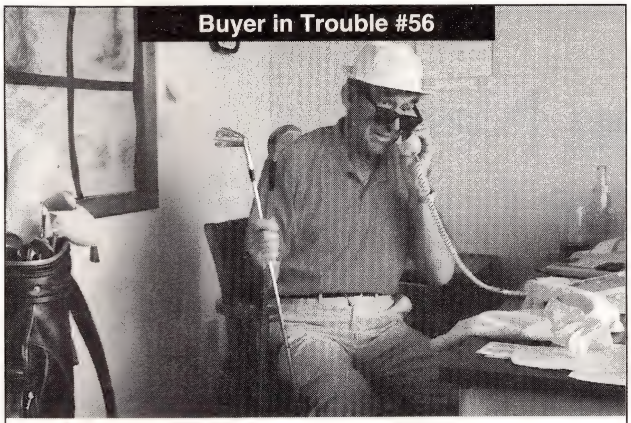
Fitting into one VMEbus slot, the VME-1486 single-board computer (SBC) comes with an Ethernet port, Super VGA video support (for CRTs or flat panels), and a fully-buffered ISA bus interface. It can hold up to 32 Mbytes of DRAM, which is sharable on the VMEbus. The board's microprocessor ranges from a 25-MHz 486SX to a 66-MHz 486DX2. The board is easily configured by the user through software, resulting in a jumperless design. Software support includes MS-DOS, Windows, OS/2, and the Lynx real-time operating system. All drivers are included. The Ethernet connection appears on the board's front panel, while an optional 10Base5 interface is accessible through the VMEbus P2 connector. In quantities of 100, the VME-1486 is priced at $1688. RN

Logical Design Group Inc., 6301 Chapel Hill Rd., Raleigh, NC 27607; (919) 851-1101. **CIRCLE 687**

CONVERT SYNCHRO OR RESOLVER TO DIGITAL

The MIP500 resolver-to-digital and MIP501 synchro-to-digital daughterboard modules let system designers customize their VMEbus, Futurebus+, and NuBus system boards. The modules, which are based on the industry-standard IndustryPack format, are available in single- or dual-channel configurations for bus-based motion-control applications in simulators, industrial automation, and test equipment. Both cards are programmable for 10-, 12-, 14-, or 16-bit resolution with maximum tracking rates of 15 revolutions/s for the MIP500 and 17 revolutions/s for the MIP501. Reference frequency range is from dc to 40 kHz. All versions guarantee loss-of-signal, loss-of-reference, and tracking-rate alarm flags. The mezzanine cards cost $995 each in small quantities. RN

Pentland Systems Ltd., 612 Exeter Pl., Danville, CA 94506; (510) 736-5113. **CIRCLE 688**



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CIRCLE 124 FOR U.S. RESPONSE
CIRCLE 125 FOR RESPONSE OUTSIDE THE U.S.

TINY, DENSE 75-W CONVERTER HAS BIG-SUPPLY FEATURES

Many potential adopters of distributed-power architectures are searching for the right mix of cost effectiveness and a full range of features in a high-density dc-dc converter. While there are multiple options open to users of converters rated for 100 W or more, the pickings are slimmer in the sub-100-W category. That has changed with the advent of the MicroMod series of supplies. The units offer more than a dozen characteristics typically found only in much higher power, fully featured "box" power supplies.

In a case measuring just 1.4 by 1.8 by 0.5 in., the MicroMod supplies offer power rating of up to 75 W, representing a power density of nearly 60 W/in.^{2}. All models have a 2:1 input-voltage range with nominal values from as low as 5 V to as high as 300 V dc. Output voltages range from 3.3 to 24 V dc.

The supplies' forward-converter topology enables all output voltages to be programmed from 125% down to zero. In addition, the current limit is programmable from nominal down to zero.

Besides having output trim and remote-sense capability, all units incorporate temperature- and current-monitoring output signals to aid in system diagnostics. Remote shutdown can be achieved by either of two pins: one on the primary side or one on the low-voltage secondary side.

A proprietary feature enables units operating in parallel to share current without any interconnections. This eliminates some of the subtle interactions which occur with the "single-wire" paralleling schemes often implemented in high-density converters. With a fixed switching frequency of about 350 kHz, the converters can be externally synchronized by a signal with a slightly higher frequency. Input-to-output isolation of as high as 4242 V dc and a metal enclosure that facilitates six-sided shielding and enhances cooling options round out the feature set.

Overtemperature, overvoltage, and indefinite-duration short-circuit protection is standard. The converters can operate into a tungsten lamp or high-capacitance load. Soft-start characteristics are built in.

Pricing for the MicroMod converters in OEM quantities ranges from $50 to $70 depending on the specific model. Lead time for moderate production quantities is typically four to six weeks.

***Power Micro Inc.**, 187 Billerica Rd., Chelmsford, MA 01824; Ed Rodriguez, (508) 250-0400.*

CIRCLE 689

■ *DAVID MALINIAK*

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CIRCLE 219 FOR U.S. RESPONSE

CIRCLE 220 FOR RESPONSE OUTSIDE THE U.S.

VHDL SIMULATORS HAVE HIGH SPEED, CAPACITY

Engineers can design ASICs, ICs, or systems with Mentor Graphics' family of VHDL simulators that come from a joint technology agreement between the company and Model Technology. The QuickVHDL Simulation Family is made up of high-speed, high-capacity simulators that have 100% compliance with the IEEE VHDL standard. Direct compiled-code technology, in which VHDL is compiled into generic RISC instructions, is what makes the simulators so fast. In fact, they're two to 20 times faster than other types of VHDL simulators. The QuickVHDL products combine Model Technology's direct-compiled-code technology with Mentor's families of top-down systems and simulation tools. A QuickVHDL package includes: a compiled-code simulator; a Design Extractor to capture, compile, and analyze VHDL and structure for simulation; a Synthesis Compiler that ensures designs can be synthesized, and a Co-Simulation Interface. The QuickVHDL Family runs on HP and Sun workstations. There are three different configurations ranging from $19,950 to $29,950. LM

Mentor Graphics Corp., 8005 S.W. Boeckman Rd., Wilsonville, OR 97070-7777; (503) 685-7000. **CIRCLE 690**

NEW FEATURES EXPAND DOS-BASED PCB TOOLS

The newest versions of two of Accel Technologies' DOS-based pc-board tools include many enhancements and additions. Version 1.4 of the Tango-Schematic entry tool adds such features as the ability to read in multiline text from an ASCII input file and place it directly on a current sheet, expanded network support that can access read-only libraries, and improved design-rule checking that summarizes errors and warnings. Also, version 2.2 of the Tango-PCB Plus board-layout software now has automatic component renumbering, enhanced split-plane design support, and the ability to suspend the route prior to completion during manual routing operation. In addition, both tools now support a European character set. Tango-Schematic and Tango-PCB Plus are shipping now for $595 and $995, respectively. LM

Accel Technologies Inc., 6825 Flanders Dr., San Diego, CA 92121-2986; (800) 488-0680 or (619) 554-1000. **CIRCLE 691**

SIGNAL TOOL SUPPORTS I/O MODEL STANDARD

Version 3.0 of the LineSim Pro signal-integrity analysis software from HyperLynx supports the IBIS 1.1 modeling specification. LineSim Pro lets digital engineers predict transmission-line problems like overshoot and ringing on their high-speed pc boards. The IBIS (I/O Buffer Information Sheet) format was originated by Intel for signal-integrity modeling, and has since been endorsed by an industry-wide group of semiconductor manufacturers and simulation vendors. IBIS describes driver and receiver components in detail sufficient for high-accuracy simulation, but without revealing the proprietary constructs of the buffers. Version 3.0 of the signal-integrity tool includes a set of IBIS models for Intel's 82430 PCIset chipset, preliminary models for the Pentium processor, and a set of models for Xilinx FPGAs. In addition, HyperLynx will distribute future IBIS models to customers on its bulletin board free of charge. LineSim Pro V3.0 runs on PCs. It's available now for $1295. LM

HyperLynx Inc., P.O. Box 3578, Redmond, WA 98073-3578; (206) 881-1008. **CIRCLE 692**

COMPLETE FPGA SYSTEM RUNS UNDER WINDOWS

Synario is a front-to-back FPGA design system that runs on a PC under MS Windows. The new design environment integrates semiconductor-vendor-supplied implementation tools with mixed behavioral and schematic design entry, functional timing simulation, and a retargeting symbol library that lets users create device-independent schematics. A generic symbol library, including gates, registers, I/O buffers, multiplexers, and arithmetic elements lets designers draw complete architecture-independent schematics that can be mapped efficiently into any device. The heart of Synario is the Project Navigator, which helps integrate the various steps in the design. With Project Navigator, users choose a process and Synario selects the necessary tools automatically, including the vendor-supplied implementation tools. Each vendor's tool is available as a device kit, which includes device-specific symbol libraries, functional- and timing-simulation models, device-fitting tools, and place-and-route software. Initial device support includes Actel, Altera, QuickLogic, and Xilinx FPGAs, as well as most CPLD and PLD families. Synario is available now for less than $6000. Pricing for the device kits start at less that $1000. LM

Data I/O Corp., 10525 Willows Rd. N.E., P.O. Box 97046, Redmond, WA 98073-9746; (800) 332-8246 or (206) 881-6444. **CIRCLE 693**

CAE SUITE FOCUSES ON COMMUNICATIONS DESIGN

A set of CAE tools called Communications Design Suite is specifically targeted at helping engineers create board-level communications designs for wireless applications. The integrated set of tools lets users simulate at both the circuit and board level with one program that automatically selects the most appropriate analysis tool for each portion of the design. The system's Project Design Environment supplies a user interface, schematic capture, data presentation, engineering documentation, file management, on-line help, and peripheral support. A system-analysis feature has the capability to simulate boards that process complex analog and digitally-encoded signals. Other features include built-in system models, RF IC-part libraries, surface-mount-technology libraries, and pc-board-layout software. Options to the base suite of tools are: transient analysis, convolution analysis, electromagnetic analysis, design-for-manufacturing capability, signal-processing analysis, and additional libraries. The Communications Design Suite runs on Unix workstations. It will be available by the end of the year for $45,000. Options begin at $3000. LM

EEsof Inc., 5601 Lindero Canyon Rd., Westlake Village, CA 91362; (818) 879-6200. **CIRCLE 694**

SBUS CARD HANDLES T3 RATES OF 45 MBITS/S

Initially developed for Sun workstations, the APC/DS3 controller card provides full DS3/T3 45-Mbit/s data transfers in one SBus compatible add-in card. Adax claims the advanced protocol controller is the first SBus card to support the 45 Mbit/s T3 throughput. The high data rate makes the card attractive for applications such as video servers, video cable distribution systems, and network backbones. The first version of the card, the APC-SBX/DS3 requires one SBus card slot. A second version, the APC EIX/DS3 card plugs into an EISA card slot in a high-end PC. Both provide multiprotocol support for X.25, frame relay, SNA, and DS3/E3 systems. The EIX/DS3 card includes 2 Mbytes of dual-ported RAM for frame storage, while the SBX/DS3 card includes 1 Mbyte of dual-ported SRAM. Either card includes a separate and interchangeable coprocessor dedicated to each channel for LAPB and LAPD error correction and flow control, as well as HDLC processing. Each coprocessor can be configured to support frame-relay or SDPC link-level protocols in the transparent mode. The on-card intelligence enhances speed and minimizes the use of host-processor cycles and interrupt overheads. As a result, the cards achieve data transfer rates of 90% to 100% of the theoretical maximums. Sample prices for either board is less than $5000, with volume discounts available. Samples are available now.

***Adax Inc.**, 614 Bancroft Way, Berkeley, CA 94710; Andrew Sproul, (510) 548-7047.*

CIRCLE 695

■ *DAVE BURSKY*

ADPCM TRANSCODER PACKS 2 CHANNELS/PACK

Providing two full-duplex ADPCM channels in a single 24-pin package, the MT9125 transcoder simplifies system designs and trims the power to just 25 mW per package. The CMOS chip simultaneously encodes two outgoing data streams and can simultaneously decode two incoming data streams.

Data rates of either 32- or 24-kbits/s, with either μ- or A-law companding, are supported by the chip, which is also compatible with the CCITT G.712 and G.723 as well as the ANSI T1.303 standards for compression and decompression.

Samples of the MT9125 transcoder are immediately available in either 24-pin plastic DIP or 28-lead PLCCs. Prices start at $15 each in lots of 1000 units. DB

Mitel Corp., 350 Legget Dr., P.O. Box 13089, Kanata, Ont., Canada K2K 1X3; Don Cordingley, (613) 592-2122. **CIRCLE 696**

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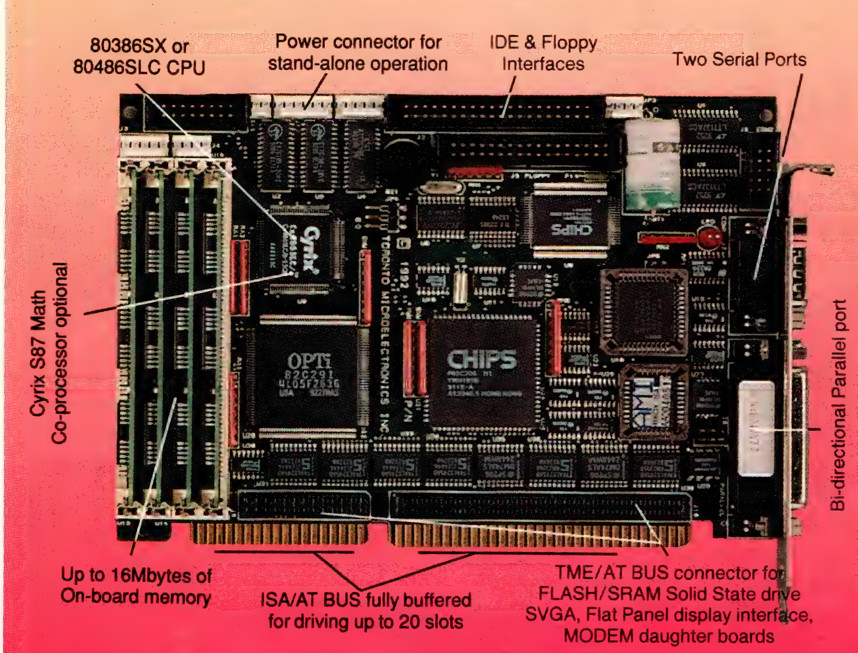
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Up to 16Mbytes of On-board memory
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TME/AT BUS connector for FLASH/SRAM Solid State drive SVGA, Flat Panel display interface, MODEM daughter boards

TME's F486SLC		COMPETITOR
✓	80386SX	Yes
✓	80486SLC	?
✓	16/25/33/40Mhz	?
✓	Up to 16 Mbytes of On-board memory	Yes
✓	64K Write back cache	No
✓	Two serial ports with 10KV ESD Protection	No
✓	One Parallel Port	Yes
✓	Floppy & IDE interface	?
✓	Under 6.5W capability	?
✓	Watch Dog Timer	?
✓	Power Fail Detection	No
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✓	Optional FLASH/SRAM Solid state drive, Flat panel display, VGA & SVGA interfaces	?
✓	Fully buffered AT BUS for driving up to 20 slots	No

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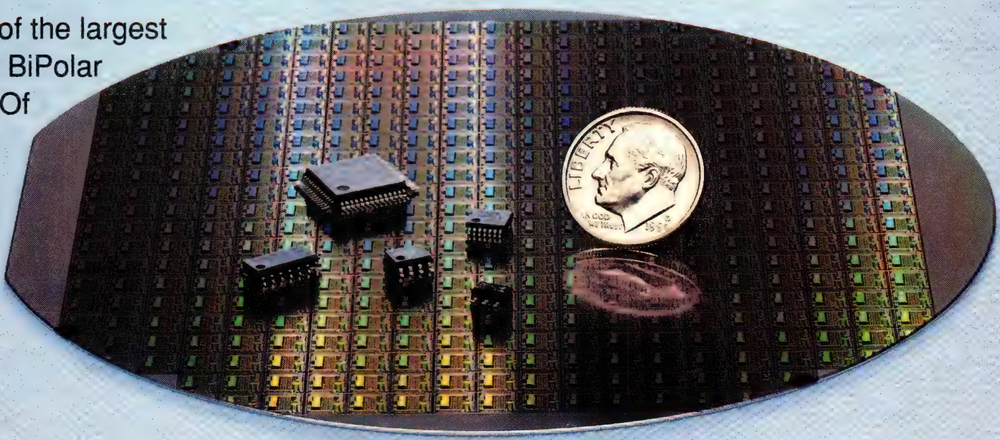

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NJU3713	12-bit Serial In Parallel Out	D, G18
NJU3714	12-bit Serial In Parallel Out with Cascade Function	D, G20
NJU3715	16-bit Serial In Parallel Out	L, G22
NJU3716	16-bit Serial In Parallel Out with Cascade Function	L, DMP24
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CIRCLE 209 FOR U.S. RESPONSE CIRCLE 210 FOR RESPONSE OUTSIDE THE U.S.

TOOLS MARRY IMAGE PROCESSING, NUMERIC COMPUTING

The Matlab Image Processing Toolbox supplies advanced image processing and robust numeric computation in an integrated, affordable environment, according to its maker, The MathWorks. With the toolbox, engineers can visualize, manipulate, and analyze images and two-dimensional signals with accuracy and flexibility.

The toolbox can analyze, filter, or enhance most images, whether from a scanned photograph or an array of electronic sensors. The toolbox's integration with the Matlab's numeric computation tools mean that users can prototype algorithms and design optical solutions to image processing problems. For example, engineers developing advanced image applications such as HDTV can design and evaluate compression and enhancement methods.

While other programs represent images as one-byte integers that may cause roundoff errors, producing incorrect results in filtering operations, the toolbox takes advantage of floating-point hardware to supply numeric accuracy. The toolbox includes at least 100 functions for linear and nonlinear filter design, filtering and image restoration, image enhancement, image analysis and statistics, 2-D transforms, and color, geometric, and morphological operations. Predefined operations such as Sobel and Wiener filtering, supply easy-to-use tools for many applications, suiting the toolbox for custom applications. Pricing starts at $895 for single user PC copies.

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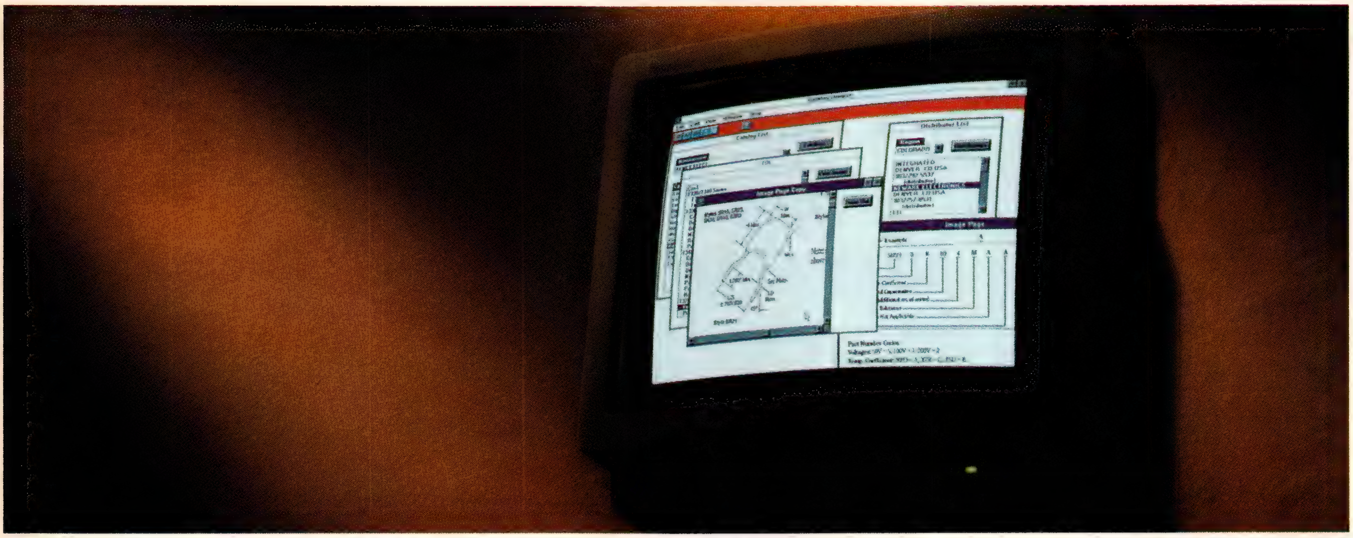

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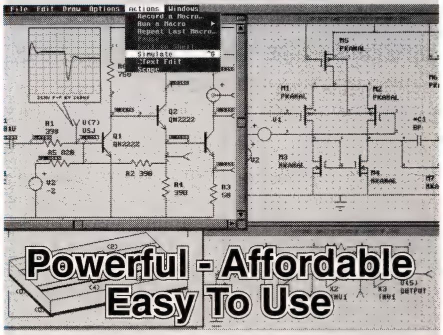

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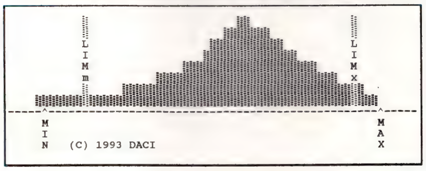

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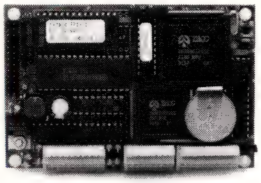

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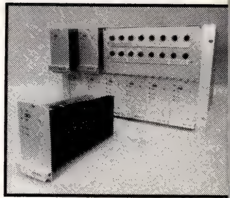

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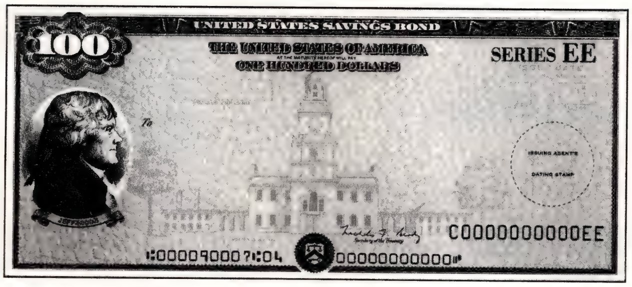

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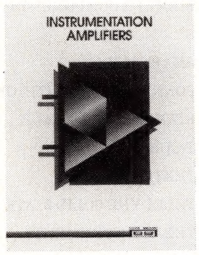

Over 20 industry-standard and recently introduced instrumentation amplifiers are covered in a six-page brochure and selection guide from Burr-Brown Corp., Tucson, Ariz. Product descriptions, specifications, and application information are all included along with three pages of technical information. Highlighted are a new family of 8-pin amplifiers including the INA111, a high-speed FET-input device, and the PGA204 and 205 monolithic, digitally controlled units. A business-reply card speeds requests for data sheets and other information. DM **CIRCLE 940**

BULLETIN LISTS TUNING ELEMENTS

A four-page engineering bulletin features Sprague-Goodman's microwave tuning elements. The Farmingdale, N.Y.-based company's Bulletin SG-670 incorporates features and specifications, plus photos, outline drawings, and charts for the six variations—metallic tuning elements, dielectric tuning elements, metallic and dielectric tuning rotors, dielectric resonator tuners, LC tuning elements, and resistive tuning elements. Contact (516) 746-1385; fax -1396. SVT **CIRCLE 941**

HEAT DISSIPATION COMPONENTS

The 1993 Heat Dissipation Components Condensed Catalog from EG & G Wakefield Engineering, Wakefield, Mass., details innovative thermal-management solutions for use in commercial, industrial, and military markets. Typical applications range from power electronic components and assemblies to systems and fabricated extrusions found in power distribution equipment, industrial control, power conversion, and transportation systems. Included in the 20-pg. catalog are power semiconductor heat sinks TO-3 through -247, and stud mount; Penguin Cooler microprocessor, ASIC, integrated circuit, and multichip module heat sinks; aluminum extrusions for power modules, IGBTs, SCRs, relays, panels, cabinets; copper and stainless steel liquid-to-air heat exchangers; liquid cold plates; precision compression mount clamp assemblies and bus blocks; manual and automatable installation tools; and thermally conductive adhesives. CM **CIRCLE 942**

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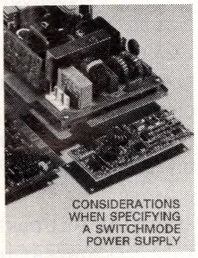

A 32-page reference handbook from MicroEnergy Inc., Longwood, Fla., sets forth considerations to take into account when specifying a switchmode power supply. The handbook is replete with information on such topics as reliability, agency approvals, electromagnetic compatibility, power-factor correction, specification writing, strife testing, custom-versus-standard, vendor selection, thermal management, and power density. Appendices are included on major safety and quality agencies, mechanical and electrical considerations, and a bibliography. DM **CIRCLE 943**

INSTRUMENTATION AMPS

A free brochure describes 20 standard and new instrumentation amps from Burr-Brown, Tucson, Ariz. The publication includes product descriptions, specifications, and application information. Three pages of technical information highlight application solutions. A business reply card makes it easy to request data sheets and other application information. SVT **CIRCLE 944**

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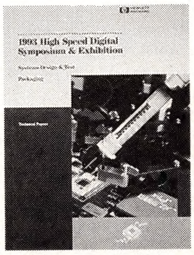

A book of papers from the 1993 High Speed Digital Symposium and Exhibition, sponsored by Hewlett-Packard, Palo Alto, Calif, includes clock-distribution networks, timing-margin verification, and managing signal-integrity effects. It also includes a feasibility study on moving a 50-MHz design to 100 MHz. Price is $20. Call (800) 765-9200. SVT **CIRCLE 947**

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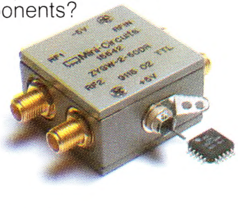

SPECIFICATIONS (typ)	Absorptive SPDT YSWA-2-50DR ZYSWA-2-50DR			Reflective SPDT YSW-2-50DR ZYSW-2-50DR		
Frequency (MHz)	dc-500	500-2000	2000-5000	dc-500	500-2000	2000-5000
Ins. Loss (dB)	1.1	1.4	1.9	0.9	1.3	1.4
Isolation (dB)	42	31	20	50	40	28
1dB Comp. (dBm)	18	20	22.5	20	20	24
RF Input (max dBm)	——	20	——	22	22	26
VSWR "on"	1.25	1.35	1.5	1.4	1.4	1.4
Video Bkthru (mV,p/p)	30	30	30	30	30	30
Sw. Spd. (nsec)	3	3	3	3	3	3
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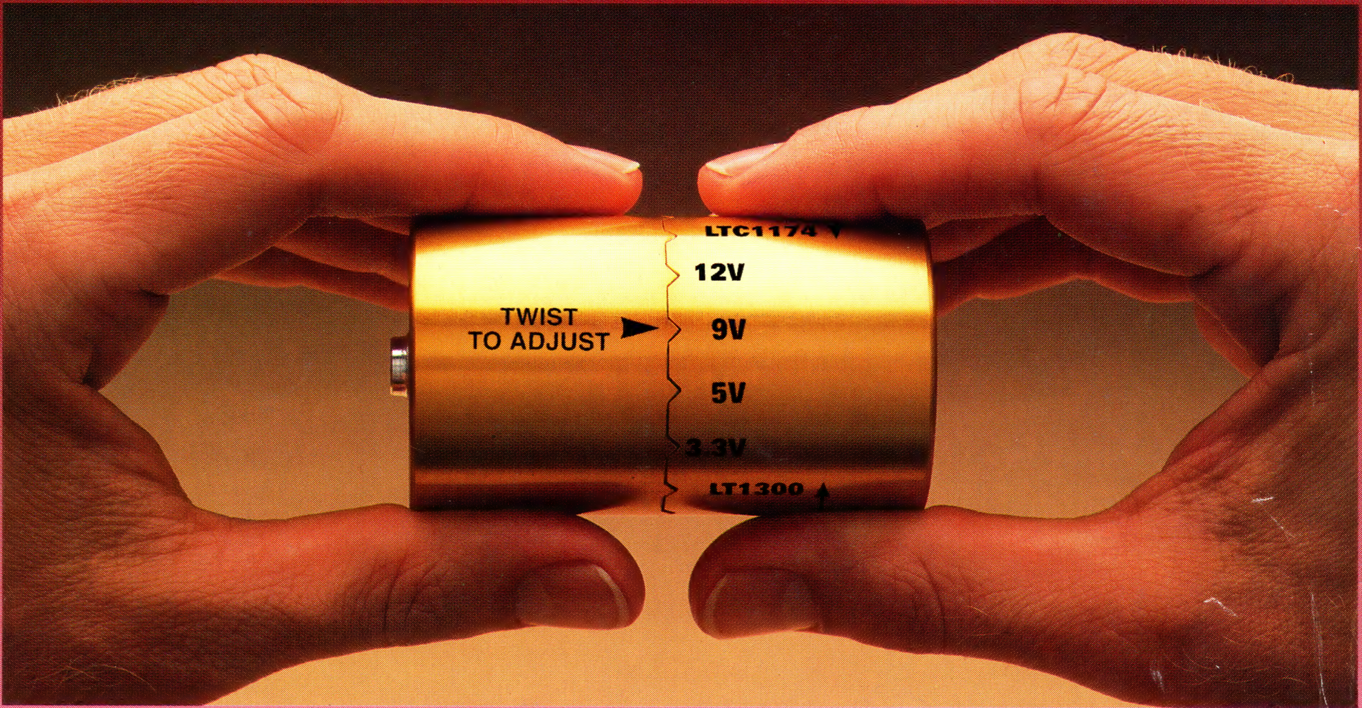

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current. Burst Mode operation maintains quiescent current at a low 120µA, which drops to only 10µA in shutdown mode. A switching frequency of 150kHz allows the use of small 10µH surface mount inductors. The LT1300 operates down to a low 1.8V input, so you can squeeze all the energy out of the battery.

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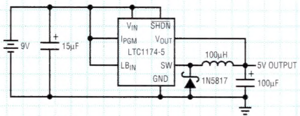
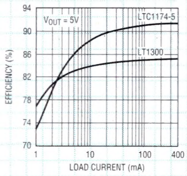
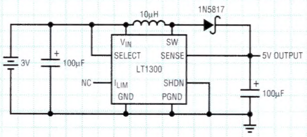




2-Cell to 5V Step-Up Converter



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